ANNALS

OF

The Entomological Society of America

VOLUME II, 1909

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CONTENTS OF VOLUME II.

PAGE

Proceedings of the Entomological Society of America..... 1
Resolutions on the Death of Dr. Wm. H. Ashmead..... 6
Resolutions on the Death of Dr. James Fletcher..... 7
Report of the Committee on Nomenclature..... 8
COMSTOCK, J. H.—A Note on the Habits of the Wall-bee Chalicodoma Muraria..... 9
PETRUNKEVITCH, A.—Contributions to Our Knowledge of the Anatomy and Relationships of Spiders..... 11
GIRAULT, A. ARSENE—A Monographic Catalogue of the Mymarid Genus Camptoptera Foerster, with Description of One New North American Form..... 22
DAVIS, JOHN J.—Studies on Aphididae II..... 30
HILTON, WILLIAM A.—The Tracheal Supply in the Central Nervous System of the Larva of Corydalis Cornuta..... 46
NELSON, JAS. A.—Evolution and Adaptation in the Palpus of Male Spiders..... 60
WEBSTER, F. M.—Investigations of Toxoptera Graminum and Its Parasites..... 67
HAYHURST, PAUL—Observations on a Gall Aphid (Aphis Atriplicis L.)..... 88
PATCH, EDITH M.—Homologies of the Wing Veins of the Aphididae, Psyllidae, Aleurodidae, and Coccidae..... 101
HINE, JAMES S.—Robberflies of the Genus Asilus..... 136
CHAMBERLIN, RALPH V.—Some Records of North American Geophilidae and Lithobiidae, with Description of New Species 175
DAVIS, JOHN J.—Two New Genera and Species of Aphididae.... 196
POULTON, PROF. E. B.—Mimicry in the Butterflies of North America..... 203
TOWNSEND, CHAS. H. T.—Descriptions of New Genera and Species of Tachinidae..... 243
COCKERELL, T. D. A.—Fossil Insects from Florissant..... 251
MCGILLIVRAY, A. D.—A Synopsis of the North American Species of Scolioneurinae..... 259
HAMBLETON, J. C.—Life History of Corizus Lateralis Say..... 272

295478

ANNALS

OF

The Entomological Society of America

Volume II MARCH, 1909 Number 1

PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF AMERICA.

The fourth meeting of the Entomological Society of America was held in Baltimore, December 30th and 31st, 1908, in affiliation with the American Association for the Advancement of Science.

The meeting was called to order by the President, Dr. W. M. Wheeler, in the Eastern High School, at 11 A. M., December 31st. The minutes of the previous meeting were adopted as printed. Dr. Fernald read the report of the committee on nomenclature. Moved and carried that this report be received and printed and discussed one year later, and that this should be the general policy in dealing with these reports. This report is appended to the minutes.

The Managing Editor made an informal report upon the condition of the Annals. Moved and carried that the chair appoint a committee on nominations. The chair appointed Messrs. C. W. Johnson, C. L. Marlatt and H. T. Fernald. The President announced the death during the year of Dr. W. H. Ashmead, an Honorary Fellow, Dr. James Fletcher, a Fellow; and of three members, C. Abbott Davis, Albert V. Taylor and Alexander Craw. The President announced that he had appointed Committees to draw up suitable resolutions upon the death of Drs. Ashmead and Fletcher. These resolutions were then read by the Secretary and adopted as read. They are appended to these minutes. A letter from Dr. L. O. Howard, concerning a request from Dr. Carlos E. Porter for separata and an offer to specialists of material for study, was read, and Mr. Webster made some explanations thereto. The Secretary read a communication from W. C. Wood suggesting action looking toward abolishing the tariff on insects. Moved and carried, "That it is the sense of this Society that the duty on insects is objectionable and should be abolished." The matter was referred to the Executive Committee with power. Adjournment until 1:00 P. M.

295478

At that time the meeting was called to order by the First Vice President, Dr. J. B. Smith. The report of the nominating committee was read, and in accordance therewith, the Secretary was instructed to cast a ballot for the following officers, which was done:

President, Dr. Henry Skinner.
First Vice President, Prof. Herbert Osborn.
Second Vice President, Dr. A. D. Hopkins.
Secretary–Treasurer, J. Chester Bradley.

Additional Members of the Executive Committee:

Prof. J. H. Comstock,	Dr. John B. Smith,
Dr. W. M. Wheeler,	Rev. Prof. C. J. S. Bethune,
Mr. E. A. Schwarz,	Prof. Lawrence Bruner.

Member of Committee on Nomenclature to serve three years, Dr. E. P. Felt, to succeed himself.

There being no further business, papers were read as follows:

W. C. O'Kane. "Notes on a Lecanio-diaspid."

A. N. Caudell spoke briefly on a method that he had adopted for preserving types. He uses Riker mounts for this purpose.

W. A. Hooker. "Contributions to our knowledge of the host relations of ticks." Discussion by Messrs. Skinner, Cooley, Viereck, Bruner and Miss Mitchell.

The meeting then adjourned.

At 3 P. M. a joint session with Section F of the American Association for the Advancement of Science was held in the Eastern High School. Dr. J. B. Smith presided over the meeting. The following papers were read:

Mr. F. M. Webster. "Investigations of Toxoptera graminum and its parasites." Discussion by Prof. Washburn and Mr. Hayhurst.

A. Petrunkevitch. "On the muscular system of spiders' legs." (Published in this number of THE ANNALS.)

J. H. Comstock. "A note on the habits of the wall-bee, Chalicodoma." (Published in full elsewhere in this volume of THE ANNALS.)

J. A. Nelson. "Evolution and adaptation in the palpi of male spiders." (To be published in full in THE ANNALS.) Discussion by Drs. Hopkins and Petrunkevitch.

Professor Williston now took the chair while the following paper was read:

J. B. Smith. "Species, varieties, races, etc." Discussion was postponed until after the reading of the next.

H. Skinner. "What is a species?" Considerable discussion was evoked by these two papers, Messrs. Williston, Fernald, Felt, Viereck, Schwarz, Caudell and others participating.

Adjournment.

At 10 A. M. on December 31st, the meeting was called to order by Dr. Wheeler, and the following papers read:

H. P. Severin. "Death-feigning by Zaitha fluminea." Read by Prof. Osborn.

C. R. Crosby. "Some habits of seed infesting Chalcis flies."

W. A. Riley. "The development of the scent-pockets of Anosia."

W. A. Hilton. "Tracheal distribution in the nervous system of larval Corydalis cornuta."

E. P. Felt. "Observations on the taxonomy of the Cecidomyiidae."

F. S. Sherman, Jr. "Recording and mapping the entomological fauna of a state."

D. W. Coquillett. "Rediscovery of the Bibionid genus Eupeitenus."

In the absence of the authors, or for other reasons, the following papers were read by title only:

S. A. Forbes, "Local relations of allied species." A. Petrunkevitch, "On some terms used in systematics." E. A. Andrews, "A colony of mound-building ants." W. E. Ritter, "The conception of unit-systems in biology." C. T. Brues, "Some further remarks on the systematic affinities of the Phoridae." A. A. Girault, "A monographic catalogue of the Myrmarid genus Camptoptera Foerster, with description of one new North American form." J. J. Davis, "Studies on Aphididae II." R. V. Chamberlin, "A Newportia in Utah."

The following report from the Executive Committee was read and, with all its provisions and recommendations, adopted:

"The Executive Committee announces the election of the following Fellows: Samuel W. Williston, Theodore Dru Allison Cockerell, Ephraim Porter Felt, Elmer Darwin Ball, Alexander Dyer MacGillivray. In June the following nine members were elected: W. O. Hart, 134 Carondelet St., New Orleans, La.; B. F. Berrenger, 3–4 Masonic Block, Fostoria, O.; Prof. E. P. Durrant, Westerville, O.; Henrik Peder Loding, 911 Palmetto St., Mobile, Ala.; W. P. Flint, Office State Entomologist, Urbana, Ill.; Charles N. Ainslie, Bureau Entomology, Washington, D. C.; Prof. A. F. Conradi, Clemson College, S. C.; H. H. Sever-

in, Columbus, O.; Walter Collins O'Kane, Columbus, O. At this meeting forty-two more have been elected as follows: Mrs. A. W. Smith, 15 E. Ave., Ithaca, N. Y.; Miss Edna Mosher, 801 Armistead Ave., Hampton, Va.; Miss Hortense Butler, Peterson, Ia.; Mr. Chas. H. Mergenthaler, 113 N. Main St., Fostoria, O.; Mr. C. H. Withington, Lawrence, Kan.; Mr. W. Reiff, Bussey Institution, Forest Hills, Mass.; Mr. F. A. Johnston, 84 Pleasant St., Amherst, Mass.; Mr. D. B' Kuhns, Honolulu; Mr. J. N. Summers, Insectary, Amherst; Mr. J. A. Hyslop, 205 D. St., N. W., Washington, D. C.; Mr. E. G. Smyth, 1100 Va. Ave., S. W., Washington, D. C.; Mr. J. F. Zimmer, 111 W. 11th Ave., Columbus, O.; Mr. R. H. Wolcott, Lincoln, Neb.; Mr. H. T. Osborn, 485 King Ave., Columbus, O.; Mr. V. L. Wildermuth, Groveport, O.; Mr. W. H. Goodwin, 39 Beall Ave., Wooster, O.; Mr. A. W. McCray, Bur. Entom., Washington, D. C.; Mr. H. C. Severin, 941 Grove St., Milwaukee, Wis.; Mr. B. M. Chatterjie, 37 Jaliapara Road, Bhowanipur, Calcutta; Mr. W. T. M. Forbes, 614 E. State St., Ithaca; Mr. J. P. Jensen, Forest Home, Ithaca; Mr. W. Moore, Ithaca; Miss A. H. Morgan, Mt. Holyoke College, S. Hadley, Mass.; Mr. A. Dutt, Coochbehar, Bengal; Mr. W. S. Regan, Amherst; Mr. C. E. Hood, Box 208, Dallas, Tex.; Mr. W. A. Hilton, 108 Brandon Place, Ithaca; Mr. W. J. Price, Blacksburg, Va.; Mr. Z. P. Metcalf, Raleigh, N. C.; Mr. W. P. Comstock, Newark, N. J.; Mr. S. A. Rohwer, Boulder, Col.; Mr. O. Bryant, Cohasset, Mass.; Miss S. D. McCann, 137 E. High St., Lexington, Ky.; Mr. W. F. Turner, Box O, Auburn, Ala.; Mr. C. J. Triggerson, 211 Hudson St., Ithaca; Mr. P. H. Hertzog, Lewisburg, Pa.; Mr. R. W. Braucher, Bureau Entom., Washington, D. C.; Mr. H. Dean, Bureau of Entom., Washington, D. C.; Mr. Nathan Banks, East Falls Church, Va.; Mr. C. P. Smith, Logan, Utah; Mr. H. G. Cribs, Philadelphia; Mr. L. L. Scott, Columbus, O.

The following suggestion from Prof. Cockerell, it is recommended, be referred to the Committee on Nomenclature: "That the Entomological Society undertake to get out a list of all North American insects to be used as a standard like the A. O. U. Code. Of course it would take years and would have to come out in parts."

"Reverend Professor C. J. S. Bethune was elected a member of the Editorial Board to fill the vacancy caused by the death of Dr. Fletcher.

"The Committee recommends the following amendment to the Constitution, to be voted on at the next annual meeting:

> "Art. 5, Sec. 3 to omit the following: 'All Officers, Secretary-Treasurer excepted, and all additional members of the Executive Committee, shall be chosen from the list of Fellows. Provided, etc.; so that the section will read: 'Art. V, Sec. 3. Election of Officers. All officers shall be elected by ballot at the annual meeting for a term of one year and shall be eligible for re-election.'

"The Committee recommends the adoption of the following by-law:

> "6. Any member may become a life member upon payment of $50.00 at one time, and shall be exempt from further assessments. He shall receive during his life, one copy of each issue of the ANNALS.

"The resignations of Messrs. G. W. Lucas, C. S. Brimley, W. F. Works, T. W. Fyles, and Miss F. H. Goodfellow were accepted.

"The following is a summary of the financial condition of the Society:

"Total receipts, including balance for 1907			$818.40
"Expenditures,	Society	$77.63	
	Annals	632.33	
			709.96
"Cash on hand, Dec. 15, 1908			$108.44

(Signed) J. CHESTER BRADLEY, *For the Committee.*

The following report from the auditing committee was accepted and the committee was discharged:

"The Committee appointed to audit the accounts of the Secretary-Treasurer and the Managing Editor of the Annals respectfully report that they have examined the same, compared them with the accompanying vouchers and found the same to be correct."

(Signed) PHILIP P. CALVERT,
Dec. 11, 1908. F. M. WEBSTER.

Mr. Viereck moved to ask the Committee on Nomenclature to define what constitutes a species and variety, taking into consideration what the ornithologists have done, and that they bring the same up before the Commission on Nomenclature of the International Congress of Zoology one year before the next meeting of that Congress.

Adjournment.

At eight P. M. in the assembly room of McCoy Hall, the annual public address was given before the Society by Dr. E. B. Poulton, Hope Professor of Zoology in the University of Oxford, on "Mimicry in the Butterflies of North America." The speaker was introduced by Vice President Smith. A large and appreciative audience was in attendance. The address was illustrated by many beautiful colored slides. It will be printed elsewhere in these ANNALS.

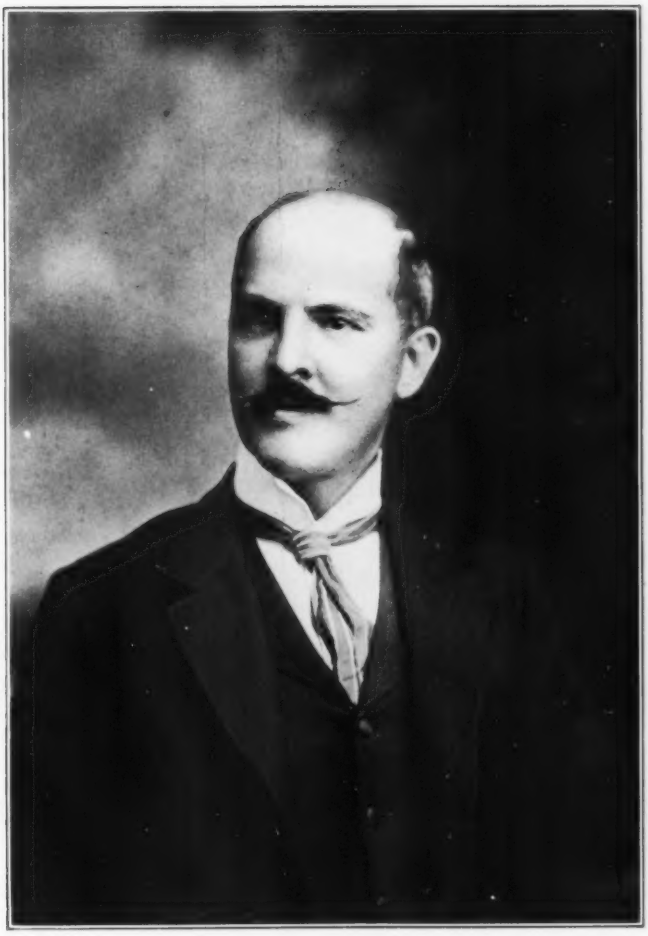
J. CHESTER BRADLEY, *Secretary–Treasurer.*

RESOLUTIONS

On the Death of Dr. Wm. H. Ashmead.

William Harris Ashmead, Naturalist, Honorary Fellow of this Society, died on Oct. 17th, 1908. We, his colleagues, would hereby give expression to our sorrow in the loss of a leader and a friend—one who gave himself unsparingly to the advancement of the science we cherish, who made himself by his zeal and industry one of the foremost students of the Hymenoptera in the world, and who furthered our progress by his numerous and valuable papers and by the prompt and generous aid he lent to every student who asked his expert knowledge and assistance. We gratefully acknowledge our debt to him, and we desire to place on record this testimonial of our esteem for him as a man, our pride in his successful career, our high regard for his scientific work, and our sincere sense of irreparable loss at his passing away.

J. H. Comstock,
J. G. Needham,
J. C. Bradley,
Committee.



WILLIAM H. ASHMEAD.

Plate I.

DR. JAMES FLETCHER.

RESOLUTIONS

On the Death of Dr. James Fletcher.

Whereas, By the untimely removal of Dr. James Fletcher, the Entomological Society of America has lost—the first by death—one of its original Fellows, and former Vice President, who presided at the Chicago meeting one year ago; and

Whereas, Dr. Fletcher, by reason of his nobility of character, kindness of heart, and zeal, tempered by good judgment, was known and beloved among scientific men not only throughout the whole of the United States and the Dominion of Canada, but also abroad, as a careful, conscientious, scientific worker, a true Christian and a thorough gentleman; and

Whereas, his death, almost in the prime of life, is a serious loss to the applied Science of Entomology as well as of Botany in America; therefore, be it

Resolved, That by and through these resolutions the members of this Society express their grief over this loss to two nations, of this truly fine, good man and colleague; and be it further

Resolved, That a page in the Annals of this Society be set aside for the purpose of placing these Resolutions on record and that the Secretary be instructed to send a copy thereof to the bereaved family.

F. M. Webster,
F. H. Chittenden,
C. L. Marlatt,
Committee.

REPORT OF THE COMMITTEE ON NOMENCLATURE.

Your Committee desires to report that since its appointment, four matters have been presented for its consideration. Of these, one was the consideration of a particular case and was soon settled. The second is still under consideration; the third it has not as yet been able to take up, and the conclusions which the Committee have reached upon the fourth case are herewith presented.

The nomenclature of gall insects was referred to the Committee as the result of a paper by Dr. E. P. Felt presented at the last meeting. The Committee is not unanimous on all points, but considers it desirable to present the following:

Report on the Nomenclature of Gall Insects.

In the literature relating to galls and gall insects, there are found several different kinds of description, accompanied by names.

(1) Those relating to the galls only, with names intended to apply to the galls, not to their inhabitants.

(2) Those relating to the galls only, but with specific names referred to particular insect genera, and intended to apply to the gall insects themselves, these being known at the time only from their work.

(3) Those relating to the galls and the contained larvae, with names proposed to be applied to the insects.

(4) Those relating to the galls and the adult insects bred therefrom, and sometimes also to the larvae, with names proposed for the insects in the usual manner.

(5) Those relating to the adult insects, the galls being unknown, with names as usual.

I. It is agreed that in cases falling under No. 1, the names proposed do not enter Zoological Nomenclature. It is also obvious that in cases 4 and 5, the names are correctly proposed, and available for use if otherwise in accordance with the International Rules.

II. It is the opinion of the Committee that specific names based on larvae (case 3) are available, and may be used.

III. With regard to the description of the gall, it is recognized that it forms a valuable part of the diagnosis of any gall insect, and that without it the recognition of the species may be difficult or practically impossible, especially when the description is not very detailed or precise. The Committee is willing to accept a name based on the description of an adult or larva plus

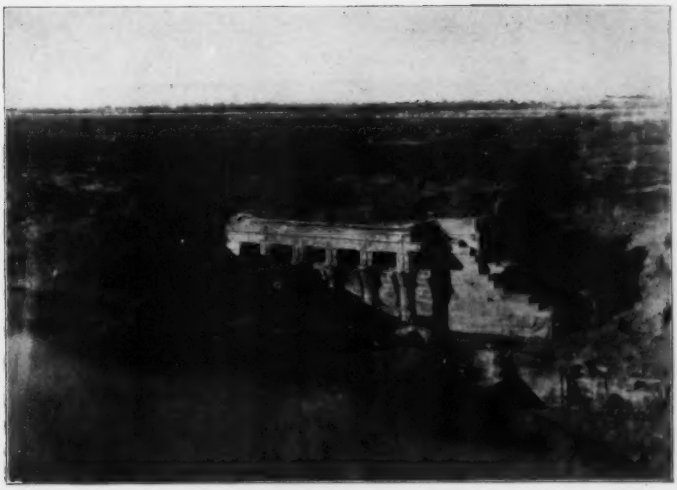


Fig. 1. Temple of Dendera.

Fig. 2. Nests of the wall-bee.

J. H. Comstock.

gall, even though the name would not be recognizable or of certain application were the account of the gall excluded from consideration.

IV. With regard to names applied as in case 2, intended to refer to the then unknown makers of known galls, it is the sense of the Committee that whenever possible, these names should be adopted.

V. The Committee is not wholly in agreement as to whether it is obligatory to maintain names (if otherwise valid) proposed as in case 2; or whether, when they are maintained, the original author and date should be cited, or the author and date of the publication in which the insect itself is first described. The majority of the Committee, however, is against the obligatory recognition of names accompanied by descriptions of galls only, and holds that when these are adopted, they properly enter nomenclature at the time of the description of the insect itself.

VI. The Committee agrees, that whatever may be the ultimate ruling on the last point, there are many practical difficulties in the way of recognizing names proposed as in case 2, so that even were such names held to be available, many of them would have to be rejected as of uncertain application. It is perfectly clear that no rules will absolve an author from using his critical judgment in the several cases that come before him; and after the rules have declared a name available from their standpoint, it may be a long way to availability from the standpoint of practical identification.

The Committee is greatly indebted to Dr. C. W. Stiles, the Secretary of the International Commission on Zoological Nomenclature, for a full and luminous discussion of the matters in dispute.

H. T. Fernald,
T. D. A. Cockerell,
E. P. Felt.

A NOTE ON THE HABITS OF THE WALL-BEE, CHALICODOMA MURARIA.

J. H. Comstock.

On the banks of the Nile, about 400 miles above Cairo, there stood for many centuries the city of Dendera, one of the most ancient and most famous cities of Egypt. According to a legend a temple was built here in the time of the Ancient Empire, *i. e.*, more than two thousand years before Christ. Of this temple we know little; but about 2000 years ago the Egyptians built

another temple here, which is one of the better preserved of the Egyptian temples.

The old city of Dendera has passed away. The houses built of brick of Nile mud have crumbled to dust, and the sands of the desert drift over much of the formerly cultivated fields. But fortunately the drifting sands buried and preserved Dendera's magnificent temple.

Modern archeologists have excavated this temple. The magnitude of the labor involved in this undertaking can be seen by a glance at Figure 1 in Plate III, which gives a general view of the temple and of the mounds of earth that have been removed from it. The object of this note is to show that, to a great extent, the prodigious work of excavation that has been accomplished is being undone by an insect.

It seems evident to a layman, I know little of Egyptology, that in the study of these ancient temples there are two main lines of investigation: first, the study of the general architectural features of the temples; and second, the reading of the inscriptions with which the walls and the columns of the temples are covered. Of these the second is certainly not less important than the first.

The temple of Dendera has been largely exposed, so that its architectural features can be studied; but the inscriptions on its walls are being rapidly buried beneath a layer of the cement-like nests of the wall-bee, *Chalicodoma muraria*, as is shown in Figure 2 of the Plate.

If future students and travelers are to see these inscriptions, it will be necessary to carefully remove this layer of nests; and as the nests are quite firm in texture, the labor involved will be considerable.

Entomologists are not accustomed to look upon this bee as a noxious insect. The studies of instinct and the embryological investigations that have been pursued upon it in Europe have made it a favorite subject of study; and I have not read of its doing serious injury there. But at Dendera it is certainly a pest; and we are warranted in suggesting means of destroying it.

The most practicable method of doing this that occurs to me is the destruction of all of the nests at frequent intervals so that no bees can develop. The duration of the larval state in this locality at the different seasons of the year should be determined as a basis for determining the frequency of the removal of the nests.

CONTRIBUTIONS TO OUR KNOWLEDGE OF THE ANATOMY AND RELATIONSHIPS OF SPIDERS.

ALEXANDER PETRUNKEVITCH, PH. D.

INTRODUCTORY REMARKS. TERMINOLOGY.

Walckenaer may have been right when in 1837 he pointed with pride to the long list of works on spiders already in existence and said that if Pallas could only see it, he would surely no longer reproach naturalists for neglecting this interesting group of animals. Unfortunately the reproach of Pallas may be repeated now more justly than ever before. It is true that a quantity of excellent work has been published since the time of Walckenaer, much more and much better work than before. But the group remains a neglected one especially if compared with such favorites as insects or vertebrates. When two years ago I began to gather material for a manual on spiders I soon became aware that our knowledge of their anatomy and embryology is entirely inadequate. Not only the nervous system and the sense organs, but even the external sexual organs from which the characters for the identification of species are chiefly derived need thorough re-examination. This sad discovery stimulated me to new research and the present series of articles is a result of it. I shall omit all reference to literature which will be extensively treated in the manual I hope to be able to complete and to publish some day. Only such papers will be mentioned as are absolutely necessary to the understanding of the subject. Moreover to avoid loss of time and to make the reading easier I shall describe things as I found them during my investigations, without making constant mention as to what is new and what was already known. Those who know the literature will easily separate the new from the old, while those who are not so well acquainted with it will be glad to have the subject treated in a short and comprehensive manner. I need scarcely add that everything described by me in the present series of articles is based on careful and extensive study.

Concerning the methods I have applied during my investigations I have little to say. They are the ones commonly used by zoologists and anatomists, i. e., dissecting with the aid of scissors, scalpels and needles for macroscopic examination, at times aided by in toto staining and injections; mounting of whole spiders or

parts in canada balsam, glycerin or some other medium; and finally sectioning with the microtome after applying the usual reagents. Used alone none of those methods is quite reliable. But when one is controlled by the others and when the number of specimens and forms studied is sufficiently great, one gets a clear idea of relations which would otherwise entirely escape observation.

To one point I desire to call particular attention. The terminology in this group is in as bad a shape as in any other group of animals. Even the names for the three planes of the body have not found universal acceptance in their application to the different groups of the animal kindgom and what is still worse the same term has often more than one entirely distinct application. Thus the term TRANSVERSE plane is used by different authors to designate each of two separate intersecting planes, which results in terrible confusion. In the case of appendages the terms upper and lower, anterior and posterior, internal and external have also been applied to the same structures, making it at times extremely difficult to understand the author's exact meaning. To avoid all misunderstanding I shall therefore give in this introduction the terms as I will use them throughout the entire series of articles as well as in my papers on systematics, the first of which will be ready for print in the near future. Whenever possible I preferred new terms to old ones, not out of desire to augment the number of terms of which there are already more than needed, but to enable the reader to know at once and exactly their meaning. Some of these terms are cumbersome and possibly could be replaced by better ones. However, clear and exact terms are in my opinion to be preferred to those which although easily remembered are at the same time easily confused.

The three determining planes of the body, applying to all animals I will call as follows:

1. THE PLANE OF SYMMETRY (called usually the sagittal or chief plane). It divides the body into two symmetrical parts, and not only in arthropods but even in echinoderms and coelenterates there is only one plane of symmetry. All planes that run parallel to it I will call *parasymmetrical*.

2. THE SYNAXONIAL PLANE (called often the frontal, and by Claus and others wrongly the transverse plane) is a plane intersecting the plane of symmetry at right angles in such a manner that their line of intersection forms the chief axis of the body

or the *axis of complex symmetry*, if I may use a term accepted in crystallography. The position of the synaxonial plane in coelenterates and echinoderms is quite exact since the chief axis itself is determined by the points of intersection of the radii. In Arthropods in which the axis is not exactly determined by the structure of the body itself, we may accept as the synaxonial plane, the plane which divides the tergites from the sternites. In the case of spiders it is the plane which separates the cephalothorax from the sternum. Any plane parallel to this plane I will call *parasynaxonial*.

3. The Diaxonial Plane (usually called the transverse plane) is a plane intersecting the former two (and the chief axis) at right angles. Any plane which does this is a diaxonial or transverse plane.

An exact terminology may be derived from these terms for the different planes, surfaces and edges of appendages, such as legs, antennae, palpi, chelae, etc., since all these are built on the principle of bilateral symmetry. In consequence they have all three determining planes of their own. Such terminology is especially important in systematics. To comprehend the new terms clearly, one must imagine all legs as growing out of the sides of the animal at a right angle to its chief axis and the chelae and mouthparts as parallel to it. (Fig. I.) For the sake of convenience we may drop the prefix "para," since this does not impair clearness. As will be easily understood from an examination of the diagram, the terms apply to both sides of the body equally well, so that it is not necessary to mention "left" or "right" and yet no confusion can result. The same term applies to a surface whether it be a leg of a mammal or of a spider, whether a front or a hind leg.

1. The Episynaxail Surface (should be epiparasynaxonial) commonly called "dorsal." The term dorsal is however objectionable since the articulation of the limbs is frequently such that the episynaxial surface is not really dorsal in position, as for example in the crabspiders.

2. The Hyposynaxial Surface (should be hypoparasynaxonial) commonly called "ventral," the latter name being objectionable on the same ground as "dorsal." The terms dorsal and ventral I will apply to the body only, not to the appendages.

3. The Prosymmetrical Surface (should be proparasymmetrical) is the lateral surface nearest to the anterior end of the

chief axis of the animal (Fig. I. pro). It corresponds therefore to the "inner" surface of the front legs, or to the "outer" surface of the hind legs in spiders. It also corresponds to the "inner" surface of the chelae in Theraphosidae called "anterior" in true spiders.

4. The Retrosymmetrical Surface (should be retroparasymmetrical) is the lateral surface nearest to the posterior end of the chief axis of the animal. It corresponds to the "outer" side of the front legs or to the "inner" side of the hindlegs. (Fig. I. retro). In the chelae it corresponds to the "outer" surface Theraphosidae, or "posterior" in true spiders.

The four edges or lines of intersection of the four surfaces mentioned in those cases when the appendages are not cylindrical in form may be called "epipro" (Fig. 2. ep), "epiretro" (Fig. 2, er), "hypopro" (Fig. 2, hp) and "hyporetro" edge, and the middle lines or the lines of intersection of the three determining planes with the four surfaces mentioned may be called the upper and lower, pro and retro middle line. In the case a structure or edge is oblique as the margins on the chelae for example, it may be simply designated by the word pro or retro. Thus the "marge inferieur" of Simon's terminology, called by Banks "the row behind the fang" and by Montgomery "the posterior margin" is according to my terminology the *Retro*margin; while the "marge superieur" of Simon or the anterior margin of Montgomery is the *Pro*margin. There can be no confusion if we apply this terminology consecutively, no matter what the actual position of the limb, if we only remember that each limb has only one plane of symmetry and that the entire terminology is based on the correlation of planes and their homology in the left and right side of the animal.

I. The Structure and the arrangement of hair on the legs of Pholcus phalangoides Fussl.

Little attention has been paid to the hair covering the legs of spiders. This is deplorable since many a valuable character may still be derived from its study, as the investigations of Dahl on the trichobothria have proven. They are of great help in the separation of families although their value should of course not be overestimated. I do not know whether the hair will eventually furnish characters of value for the separation into genera, but it has been already applied for the separation into species of

the genus Latrodectus and it certainly will help to establish relationships between forms which would otherwise remain separated in the system.

While studying the muscular system and articulations in Pholcus I was struck by the regularity of the rows of hair on the legs. A comparison of many specimens showed that this is a constant character. The leg has not the form of a perfect cylinder, but shows in a cross-section a circle with flattened sides, represented diagrammatically in Fig. 2. There are in all 8 rows of hair; two rows on the episynaxial surface (esp and esr), one on the middle pro (mp) and one on the middle retro line (mr), and four rows on the four edges (ep, er, hp, hr). We find the same arrangement on each segment of all legs beginning with the femur; but the tarsus of the fourth leg in both sexes has a ninth row of hair on the middle hypo line. The onychium of each tarsus is surrounded in all legs by 8 bristles, two of which are unpaired and belong to the tarsus. The structure of these bristles may best be understood from the drawing. (Fig. 4.)

The hair forming the eight rows on the femur and tibia is of uniform structure. It is represented in Fig. 5, in its entire length and a part of it on a larger scale in Fig. 6. It is characterised by the spiral row of small spines reaching a little beyond its middle. Each hair is inclined towards the distal end of the limb at an angle of from 27–30 degrees. In a female of 2 mm. cephalothorax length the hair on the femur marked in Fig. 2, with the letters *esp* and *esr* is about 0.8 mm. long, while that forming the other four rows is only 0.57 mm. long. In the tibia all rows consist of hair of the average length of 1.0 mm. There are no trichobothria on the femur and tibia, but on the latter are some six or seven extremely small hairs without any special structure, measuring about 0.06 mm. The hair of the metatarsus is considerably shorter than that of the tibia, but still of the same structure in its proximal two thirds. The longest hair is at the base of the metatarsus measuring in the above individual 0.4 mm. Towards the distal end of the metatarsus the hair becomes gradually shorter and changes structure. It measures now only about 0.28 mm. loses the spiral of small spines, while the two basal spines—the only ones remaining—become considerably stronger. (Fig. 7.) There are besides some six or seven scattered hairs measuring about 0.12 mm., simple at the proximal end of the segment and toothed at its distal end, where it looks as represented

in Fig. 11. This hair may be bent anteriorly or erected more than the common hair. Its teeth are directed away from the tip of the limb. Similar hairs, only shorter and with longer teeth are found on all tarsi, about one dozen in number (Fig. 10). The hair forming the eight rows on the tarsi is of the same structure as that at the distal end of the metatarsus, but also smaller, measuring from 0.2–0.28 mm. and with stronger basal spines (Fig. 8) to which two more are sometimes added. The fourth leg in both sexes has besides, as already mentioned, a ninth row of specially structured hairs. They occupy the hypomiddle line and are from thirty to thirty-four in number. They have hooks on one side and little spines on the other (Fig. 9) and are so arranged that the spines are directed distally towards the tip of the limb. Although each hair measures only 0.12 mm. *this row doubtless is homologous with the comb of the Theridiidae*, since the position of the row is in each case the same and the structure of the hair, if we disregard its length, very much alike. This brings the family of the Pholcidae, originally regarded as a subfamily of the Theridiidae and later separated from the latter family, into closer relation with it again. Such opinion is further substantiated by the fact that other representatives of the Family Pholcidae show similar conditions. In Spermophora meridionalis the row consists of 16 hairs one of which is represented in Fig. 12. In two species of Modisimus from Jamaica I find this row represented by hairs of the type found in the other eight rows, but the distal four hairs show distinct teeth or spines characteristic for the combhair. In Pholcus tipuloides the whole row differs from that of Pholcus phalangoides, resembling more the lower end bristle of this latter species and thus constituting a character in itself sufficient to keep the two species apart. On the other hand neither Hypselistes (Erigone) florens, nor any of the five common species of Linyphia examined, show anything of the kind.

II. On the Muscular System of the legs.

The muscular system of the legs in spiders has been studied several times. The last paper of importance was that by Paul Gaubert in the Annales des Sciences Naturelles, Vol. 13, 1892. Yet neither his studies, nor those of Börner have brought the question to a conclusion. Moreover they contain errors. Thus one of the muscles of the patella was entirely overlooked and another in the tibia wrongly described and in consequence its function misunderstood.

I used as material transparent legs of small spiders. They can be studied in life, or after enclosure in glycerin, or by fixing the whole leg in picric acid which stains intensely and permanently yellow the muscles and by enclosing it then in canada balsam. Side views were controlled by dorsal and ventral views of corresponding segments. In some cases sections were necessary and the paraffin-method was used. Besides small spiders I have also studied the muscular system in several very large spiders, such as Heteropoda venatoria, Ctenus malvernensis sp. n., Lycosa carolinensis, Pachylomerus nidulans and unidentified species of Eurypelma. In all these the muscles can be isolated with the aid of dissecting instruments even without a magnifying glass.

Coxa. Enclosed in the coxa are five muscles one of which really belongs to the trochanter and will be described with the other muscle of that segment. The four muscles belonging to the coxa are: 1. *M. flexor trochanteris* (Fig. 3, fl. tr.) This muscle arises from the episynaxial surface of the coxa and partly from the chitinous septum which occupies the synaxial plane of the coxa and divides its anterior two thirds into an upper and lower half. The muscle is inserted with a tendon into the proximal epi-edge of the trochanter. 2. *M. extensor trochanteris* (Fig. 3. ex. tr.), the antagonist of the preceding arises from the hyposynaxial surface of the Coxa and partly from the septum. Its tendon is inserted into the proximal hypo-edge of the trochanter. 3. *M. promotor trochanteris*, a broad muscle with parallel fibres which arise from the prosymmetrical surface of the Coxa and are inserted without tendons into the proximal prosymmetrical edge of the trochanter. 4. *M. retractor trochanteris* (Fig. 3. r. tr.) the antagonist of the promotor occupying the symmetrical position on the retro-side.

Trochanter. Two muscles are enclosed in the trochanter. 1. *M. flexor femoris longus* (Fig. 3. fl. f. l.) a weak muscle which arises from the coxal septum and is inserted by means of a tendon into the proximal epi-edge of the femur. Gaubert, who calls this muscle "abaisseur," describes it as arising from the inferior (Hyposynaxial of my terminology) surface of the coxa, not from its septum. I think that in some cases I have seen fibres running in that direction, but I am not positive about it. The function of this muscle is certainly not that of the common flexor but it is not an "abaisseur" (depressor), since it probably helps the flexor bilobatus to lift the femur and at the same time tends to bring

the whole femur nearer towards the trochanter. 2. *M. flexor femoris bilobatus* (Fig. 3. fl. f. b.) consists of two symmetrical halves arising from the hyposynaxial surface of the trochanter. Its numerous short tendons are inserted close together into the same edge with the flexor longus.

FEMUR. Enclosed in the femur we find two muscles closely resembling those of the trochanter. 1. *M. flexor patellae longus* (Fig. 3. *fl.* p. l.) has two proximal tendons one of which arises from the distal end of the hyposynaxial surface of the trochanter and the other from the corresponding proximal end of the femur. The fibres soon form one spindle-like muscle which is inserted with a long tendon into the proximal hypo-edge of the patella. 2. *M. flexor patellae bilobatus* (Fig. 3. fl. p. b.) is in every respect homologous with the corresponding muscle of the trochanter, but as the flexor femoris *raises* the femur, while the flexor patellae *lowers* the patella together with the tibia, the two homologous muscles arise from the opposite surfaces. It is the articulation of the segments that determines the position of muscles. The musculus flexor patellae bilobatus consisting of two symmetrical halves arises therefore from the entire episynaxial surface of the femur and its numerous short tendons are inserted close together into the proximal hypo-edge of the patella on both sides of the long flexor.

PATELLA. The articulation of the patella with the tibia is such as to allow of scarcely any motion. Notwithstanding this we find three muscles in the patella. Two of these are symmetrical and consist of parallel fibres arising from the episynaxial and the pro- and retrosymmetrical surfaces of the segment. Each separate fibre is inserted apparently without a tendon into the proximal pro- and retro-edges of the tibia. These two muscles are: 1, *M. promotor tibiae*, and 2, *M. retractor tibiae* (Fig. 3. r. t.) The third muscle which is also to all appearances functionless is 3, *M. flexor tibiae*. It arises from the proximal end of the episynaxial surface of the patella and is conical in shape. Its long cylindrical tendon is inserted into the middle of the proximal hypo-edge of the tibia. This muscle is entirely overlooked by previous investigators although it may easily be found in spiders of different families and all sizes.

TIBIA. The muscles of the tibia are in every respect homologous with those of the femur. A number of fibres arise from the proximal surface of the patella without however forming a tendon,

and join in the tibia those fibres which arise by means of a tendon from the proximal hypo-edge of this latter segment. Together they form the 1.—*M. flexor metatarsi longus* (Fig. 3. fl. m. l.) which is inserted with a long tendon into the middle of the proximal hypo-edge of the metatarsus. 2, *M. flexor metatarsi bilobatus* (Fig. 3. fl. m. b.) is composed of two symmetrical halves and arises from the entire episynaxial surface of the tibia. Its numerous short tendons are inserted closely together on both sides of the tendon of the long flexor. The description of this muscle given by Gaubert is entirely wrong and I am not able to comprehend what has brought him to the conclusion that its point of insertion is on the dorsal (episynaxial) surface of the metatarsus and that this muscle is therefore an extensor. There is no extensor of the metatarsus.

METATARSUS. Enclosed in the metatarsus are two muscles, one of which is the antagonist of the other. 1, *M. flexor unguium* (Fig. 3. fl. u.) arises from the proximal surface of the metatarsus and receives additional fibres which arise from the distal end of the episynaxial surface of the tibia. Its long, thin tendon traverses the metatarsus and tarsus and is inserted into the base of the claws. 2, *M. extensor unguium* (Fig. 3. ex. u.) arises from the proximal epi-edge of the metatarsus and is inserted by means of a long and thin tendon which runs above and parallel to that of the flexor into the base of the claws above the latter.

TARSUS. The tarsus has no muscles and encloses merely the two tendons above mentioned.

In reviewing the muscular system of the legs in spiders we observe that its characteristic feature is the absence of extensors in the majority of segments. Only the coxa and the metatarsus enclose extensors.[1] The function of the extensors is evidently transferred in the other segments upon the hypodermis forming a thin elastic membrane over each joint. The homology of the muscles enclosed in the femur and tibia is too apparent to admit of doubt, and I believe that it can be extended to the muscles

1. In the second volume of his text-book of experimental zoölogy, which has just appeared, Przibram reproduces Frédéricg's diagram of the muscular system of a spider-leg. Evidently misled by Garber's old interpretation of the muscular system of appendages in Arthropods, he figures a flexor and an extensor in every segment of the limb. However, even a superficial examination of the articulations cannot fail to show that his supposed extensors are in reality flexors. If he had noticed that the axes of the patellar and metatarsal articulations lie not on the ventral side of the limb, but in its episynaxial (dorsal) surface, he would have escaped this error.

enclosed in the trochanter. Such conception is certainly true in the case of the flexor bilobatus. As for the flexor femoris longus, some doubt may be expressed as to its homology with the corresponding flexors of the patella and metatarsus. But the shortness of the trochanter and the difference in articulation may be held responsible for the fact that the flexor femoris longus arises from another surface than its homologs. The muscles of the patella are doubtless homologous with those of the coxa with that exception that there is no extensor tibiae. We must however remember that an extensor tibiae would be of still less use than the flexor, since the patella has a special tooth at its distal end interlocking with the tibia. This interlocking device prevents the tibia from being raised apart from the patella, the only functioning "knee" articulation being that between the femur and the patella.

EXPLANATION OF THE FIGURES (PLATE IV.)

1. Diagram of a spider showing the axis of complex symmetry, AP, and the planes of symmetry of the legs, pd, and of the chelae. The second and third legs on the right side are removed. The figure represents the dorsal surface of the spider and the legs are extended in such a manner that the surface of the paper represents the episynaxial surface.

2. Diagram representing a cross section of the leg of Pholcus phalangoides. EH, the plane of symmetry. It is understood that the observer sees the cross section in looking from the body of the spider towards the end of the leg. In consequence it is evident from the letters accompanying the diagram that it is a cross section of a right leg. In a left leg the two halves are reversed. ESP, proepisynaxial; ESR, retoepisynaxial; EP, apipro, ER, epiretra; MP, middle pro; MR, middle retro; HP, hypo pro; HR, hyporetro hair.

3. The muscular system of a spider leg. fl. tr., flexor trochanteris; ex. tr., extensor trochanteris; r. tr., retractor trochanteris. Its antagonist, the M. promotor trochanteris, runs parallel to the retractor and cannot therefore be represented on the diagram. One must imagine that it was removed for the purpose of showing the other muscles. fl. f. l., flexor femoris longus; fl. f. b., flexor femoris bilobatus; fl. p. l., flexor patellae longus; fl. p. b., flexor patellae bilobatus; fl. t., flexor tibiae; r. t., retractor tibiae. Its antagonist the M. promotor tibiae runs parallel to the retractor and could not be represented in the diagram. fl. m. l., flexor metatarsi longus; fl. m. b., flexor metatarsi bilobatus; flu., flexor unguium; ex. u., extensor unguium- tn. f., the tendon of the flexor; tn. e., the tendon of the extensor.

4. The bristles surrounding the claws of Pholcus phalangoides. The heavy upper and lower bristles are single. Three bristles corresponding with the three other bristles of the figure are situated on the other side of the claws and can not be represented.

5—11. Hairs on the legs of Pholcus phalangoides. 5, on femur, patella, tibia and the two proximal thirds of metatarsus. 6, a part of the same hair stronger magnified. 7, a hair from the distal end of the metatrasus; 8, a hair from the tarsus. 9, the combhair of the fourth tarsus. 10, one of the few erect, scattered hairs on the tarsus. 11, the same from the metatarsus. 12, one of the combhairs of Spermophora meridionalis.

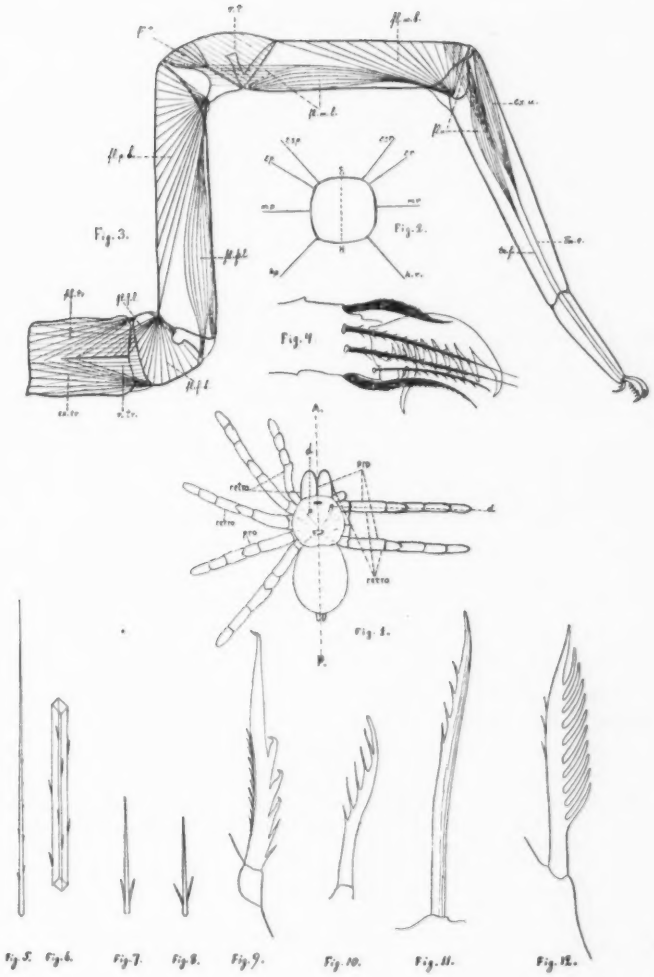


Fig. 3. Fig. 2. Fig. 4

Fig. 1.

Fig. 5. Fig. 6. Fig. 7. Fig. 8. Fig. 9. Fig. 10. Fig. 11. Fig. 12.

Alexander Petrunkevitch.

A MONOGRAPHIC CATALOGUE OF THE MYMARID GENUS CAMPTOPTERA FOERSTER, WITH DESCRIPTION OF ONE NEW NORTH AMERICAN FORM.

A. Arsène Girault, University of Illinois.

In recording the discovery of another new form of this genus from North America, I have thought it helpful to bring together the original descriptions of the few known species, and to sum up our knowledge concerning the group. What we know of the genus, however, amounts practically to very little. But three species have hitherto been described, none of them any too well.

HISTORY OF THE GENUS.

The genus *Camptoptera* was originally characterized by Arnold Foerster in 1856 (Foerster, 1856, p. 116) as follows:

"28. Mymaroidae. Die mir bekannten Gattungen lassen sich nicht alle, ohne die ♂ und ♀ zu trennen, in eine einfache und klare Uebersicht bringen. Das nachfolgende Schema wird daher einige Gattungen doppelt aufführen:

a. Die Tarsen fünfgliedrig.

b. Der Hinterleib deutlich gestielt.

c. Die Fühler beim ♂ zehn-, beim ♀ neungliedrig.
Camptoptera *m.**)

cc. Die Fühler beim ♂ dreizehn-, beim ♀ eilfgliedrig.
Ooctonus *Hal.*

bb. Der Hinterleib sitzend oder fast sitzend.

d. Die ♂" *etc.* p. 116.

Further on (Id., p. 119), he gives the characters of the group as follows:

"Unter dem Namen Camptoptera habe ich eine pentamere Gattung aufgestellt, welche durch ihre winzige Form sich nur mikroskopisch bestimmen lässt. Da ich dieses Thierchen erzogen habe und lebend untersuchen konnte, so will ich mich hier etwas weitläufiger darüber verbreiten. Der Gattungscharakter lautet:

Tarsen fünfgliedrig; Fühler beim ♂ zehn-, beim ♀ neungliedrig; Hinterleib kurz gestielt; Flügel schmal, mit einem breiteren Absatz nahe an der Basis und hinter demselben gebogen."

A description of the species (*papaveris*) upon which the genus was founded then follows in the next paragraph; although this

"*)Camptoptera von καμπτός, ή, όν, gekrümmt, gebogen und πτερόν, τό, der Flügel. Die Vorderflügel sind in dieser Gattung ziemlich stark gebogen."

species is not designated as the type, under the code it becomes such (monotpyical genus, Stiles, 1905), and was formally designated as such by Ashmead (1904).

Still later on, in the same work, under the heading *Nachtrag*, Foerster (1856, p. 144) proposed to change the name of the genus from *Camptoptera* to *Pteroclisis* on the ground that "da bereits durch *Presl* der gleichbedeutende Name Camptopteris in die fossile Flora eingeführt wurde." This proposed change rightly was not accepted by later authors and under both the present code (Stiles, 1905, p. 10, independence from botany; p. 25, page precedence) and the law of priority, the second name is abandoned. The incident is stated as a matter of history.

The genus has received little or no attention since its establishment by Foerster, but later authors (Provancher, 1889; Cresson, 1887; Ashmead, 1904) have persisted in spelling it *Camptotera*.

The former author gives the following generic description (Provancher, 1889):

"Gen. 11. Camptotère. *Camptotera*, Först.

Antennes insérées sur le front, non près de la bouche. Abdomen plus ou moins arrondi sur les côtés. Ailes posté-térieures très petites, presque linéaires, sans nervure médiane. Abdomen pétiolé; tarses de 5 articles.

Une seule espèce rencontrée."

DISTRIBUTION OF THE GENUS.

This genus is now represented in Europe and North America; *papaveris*, the European species was described from Germany; Provancher described *clavata* from the vicinity of Quebec, Canada, while *metotarsa* Girault was described from Virginia and *pulla* Girault is now described from Illinois.

HOST RELATIONS OF THE GENUS.

Of the species *clavata*, *metotarsa* and *pulla* nothing is known about their hosts, all of them having been described from captured specimens; however, *papavaris*, says Foerster, "erzog ich vom 12. bis 18. August 1851 aus Mohnkapseln von Papaver Rhoeas und dubium, worin die Gallen vou Aulax Rhoeadis sich befanden." Foerster (1856, p. 120) further adds in the next paragraph: "Ob nun die Larven der Gattung Camptoptera an den Larven oder in den Eiern der Gallerzeuger, hier des Aulax Rhoeadis *Hart.* parasitisch leben oder die Cecidomyia angreifen, oder gar die übrigen

Parasiten vernichten, darüber habe ich mir keinen Aufschluss verschaffen können, wird aber jederfalls von Interesse sein und hoffentlich auch von anderer Seite nicht ohne Beachtung bleiben." The species was reared from poppy capsules containing a cynipid gall and from which were reared also a cecidomyiid and three other species of Hymenoptera; its host relations are therefore problematical and it would be hazardous to attempt to connect it with any of the possible hosts mentioned. This being the case, it is seen that at present, of the four species of the genus, nothing is known concerning their economy in nature. De Dalla Torre (1898, footnote) on the contrary makes Foerster's rearing a definite one, giving the host as *Cynips papaveris* (Perris) Mayr, and the authority as Rondani. This Cynips is synonymic with *Aulax rhoeadis*. The assumption in regard to this host is all the more arbitrary because of what Foerster himself states in regard to the rearing. Kaltenbach (1874) also gives Foerster's rearings.

Family Mymaridae.
Subfamily Gonatocerinae.
Tribe Ooctonini.
Genus *Camptoptera* Foerster, 1856, pp. 116, 119, 144.
(Type:—*Camptoptera papaveris* Foerster).

1. *Camptoptera papaveris* Foerster.

Foerster, 1856, pp. 119–120. Kirchner, 1867. Snellen van Vollenhoven, 1873. De Dalla Torre, 1898, p. 431. Ashmead, 1904, pp. 362, 369.

"Bräunlich, der Schaft mit dem Stielchen, der Hinterleibsstiel und die Beine gelb; die Füsse fast unmerklich dunkler als die übrigen Theile der Beine. Das ♂ hat die Geisselglieder alle ungefähr gleich lang, jedoch so, dass die vier bis fünf ersten Glieder fast unmerklich länger erscheinen, als die folgenden; das letzte ist mit einer sehr feinen pfriemenförmigen Spitze versehen. Die Fühler stehen hart am innern Augenrande. Beim ♀ ist das erste Geisselglied etwas länger als das Stielchen, das zweite viel länger als das erste, das dritte etwas kürzer als das erste und das vierte sogar kürzer als das dritte. Die beiden folgenden unter sich genau von gleicher Länge, einzeln genommen wenig, aber doch merklich kürzer als das dritte. Das letzte Glied bildet eine ziemlich stark verlängerte, fast elliptische Keule von der Länge der drei vorangehenden Glieder. Die beiden der Keule vorhergehenden Glieder sind auch ein wenig dicker als die übrigen Geisselglieder.

Camptoptera Papaveris *m.* ♂ ♀, die einzige Art dieser Gattung, erzog ich vom 12. bis 18. August 1851 aus Mohnkapseln von Papaver Rhoeas und dubium, worin die Gallen von Aulax Rhoeadis sich befanden. Aus denselben Kapseln und zu derselben Zeit erzog ich ferner: Pteromalus Papaveris *m.* ♂ ♀. Cecidomyia Papaveris

*Winn.***)[a] Pezomachus Papaveris *m.* ♂ ♀ (das ♂ ungeflügelt!!!) Lochites Papaveris *m.* ♂ ♀ (worüber bereits oben Seite 44 berichtet wurde!) und ein kleiner Encyrtus.

Ob nun die Larven der Gattung Camptoptera an den Larven oder in den Eiren der Gallerzeuger, hier des Aulax Rhoeadis *Hart.* parasitisch leben oder die Cecidomyia angreifen, oder gar die übrigen Parasiten vernichten, darüber habe ich mir keinen Aufschluss verschaffen können, wird aber jedenfalls von Interesse sein und hoffentlich auch von anderer Seite nicht ohne Beachtung bleiben." pp. 119–120.

This description is rather brief, lacks detail and it is more or less doubtful if the species could be again recognized from it, so that I have drawn up another from a female specimen nicely mounted in balsam by Mr. Frederick Enock of London and determined by an English authority; as no other valid specimens of the species exist, so far as I am aware, this description definitely fixes the species; it will be seen readily that it agrees in general with the original, though drawn up before that description was consulted.

Redescription of *Camptoptera papaveris* Foerster, female.

Female.—Length, 0.91 mm.; minute; visible to naked eye. General color yellowish brown; legs and basal five joints of antennae paler; ocelli red; eyes dark; vertexal carina present, usual. Fore wings slightly infumated at basal one-third, normal, curved at the apical fourth, with the usual dilatation along the caudal margin near base, the usual dusky yellow margins and with one principal row of discal cilia in the distal half of the wing (excluding the ones along the margin, dorsad), joined by two others on each side, near the cephalic and caudal margins respectively, of the wings, in the apical fourth; proximad of the apical fourth of the wing, these two lines of cilia become lost in the margins; venation dusky yellowish, inconspicuous. Hind wings hyaline, with two main rows of discal cilia, one on each side near the margins, in the distal half of the wing; marginal cilia of hind wings nearly as long as those of the fore wings, and with the usual colorless spot or area near their bases, forming the clear whitish path a short distance beyond the distal end of the wing, and which follows the outline of the wing margin at that point. Petiole apparently acute at its center, lateral aspect (as in *pulla*) and with a clear spot at its base, dorsal aspect; posterior tibiae slender, longer than the posterior tarsi; the joints of the tarsi subequal, the basal joints inclined to be slightly longer.

Antennae longer than the body; scape convexly curved, about as long as the combined lengths of the pedicel and 1st funicle joint; pedicel conic-ovate, its cephalic margin serrate, thicker than the scape and much more so than the slender first three funicle joints, but nearly one-half shorter than the first funicle joint; the latter slender, cylindrical, slightly narrowed in the middle, one-third shorter than funicle 2 and the next to the longest joint of the funicle; funicle 2 the longest funicle joint, long and slender, one-third longer than 1, longer than the scape and about equal to or slightly longer than the combined lengths of the next two joints (funicles 3 and 4), subequal to the club in length, but one-half narrower; funicle joints 1–3 of the same width, narrow and cylindrical; funicle 3 a little over half the length of funicle 2 and slightly enlarged at the apex, longer than either of the following joints and also the pedicel; next three joints (funicles 4–6) gradually enlarging to club; funicle 4 cylindrical oval, distinctly wider than 3 and one-fourth shorter, subequal in length to 5; the latter slightly wider; funicle

a. The footnote to which the asterisks refer is omitted here, having no relevancy.—A. A. G.

6 one-fourth shorter than the two preceding, ovate, subequal in length to the pedicel, the shortest funicle joint; club ovate, subequal to the combined lengths of the three preceding joints (funicle 4–6), and from one-third to one-half wider than funicle 6, and from 2 to 3 times the width of funicles 1–3, longer and wider than the scape; more slender in proportion to the other joints than usual. (Fig. 1. Flagellum of female, the setae omitted.)

(From 1 ♀, 2–3 inch objective Bausch and Lomb.)

Fig. 1. Flagellum of *Camptoptera papaveris* Foerster female greatly enlarged.

Redescribed from a specimen beautifully mounted in balsam by Mr. Frederick Enock of London, and being one determined by an English authority and in the collection of Dr. L. O. Howard.

Very similar, excepting in coloration and wing characters, to *pulla* Girault. The antennae are very similar.

2. *Camptoptera clavata* Provancher.

Provancher, 1889, p. 404. De Dalla Torre, 1898, p. 431.

"Camptotere en-massue. *Camptotera clavata*, n. sp.

♀—Long. .09 pce. Noire, polie, brillante, les antennes et les pattes jaune–orange. Face inférieure; antennes insérées sur un rebord du front, de 10 articles ♂ et 9 articles ♀. Cuisses plus ou moins renflées; tarses de 5 articles. Abdomen pédiculé, le reste formant une massue en pointe à l'extrémité.—Ste Gertrude."

This brief, general description is inadequate for recognition of the species, which on this account is probably lost to science and will have to be rediscovered and renamed. The whereabouts of the type is unknown to me.

3. *Camptoptera metotarsa* Girault.

Girault, 1905, p. 91.

"Female. Length, 0.90 mm.

Shining black, the abdomen polished black. Legs, excepting the coxae and apical joint of tarsi, basal three-fourths of the scape, and the venation, brown.

Head about as wide as the thorax, the eyes subovate, coarse, and very dark red; ocelli inconspicuous. Head and thorax coarsely shagreened, the latter short and convex, slightly longer than abdomen; parapsidal furrows absent. Abdomen depressed, short, oval. Legs long, the first tarsal joint long, the coxae rather large and coarsely shagreened, the posterior femur with a convexity or swelling in the middle of its upper margin. Wings iridescent, very slightly clouded, the fore wings narrow, curved, the marginal fringes rather long. Body nearly hairless.

Antennae elbowed, about as long as the body, 9-jointed. Scape very long, subclavate, narrow basally, about as long, or not quite so, as the next three joints combined, or about five times the length of the pedicel. Pedicel short, very much smaller, obconic. Joints 3 and 4 slender, cylindric, 4 longer, about twice the length of the pedicel, both slenderer than the scape and pedicel; 5, 6, and 7 equal, columnar, stouter than 3 and 4, but much shorter, yet far longer than the pedicel. Joint 8 equal to 5, 6 and 7, but slightly stouter. Club cylindric, not as long as the scape, but much stouter, about equal in length to 6, 7, and 8 combined.

From a single female captured while jarring peach at Arlington Virginia, June 2, 1905. A rather large and striking species.

Type.—No. 8941, United States National Museum." 1 ♀, tagmounted. Male, unknown.

This description also is not as detailed as it might be. The type, being an unique, has not been accessible, but Mr. J. C. Crawford, of the United States National Museum, Division of Insects, at my request, kindly furnished the following additional and important descriptive details: The petiole is acute or barbed at the lateral margins, as in *pulla;* the vertexal carina is present; and there are four rows of discal cilia on the fore wings—one near the cephalic margin; two, not in stright lines, along the middle portion of the wing, one on each side of a darkened line on the wing, the line representing an obsolete vein; and the fourth near the caudal wing margin. I am also informed that the type specimen is broken, the head and thorax together parted from the abdomen, but remounted on the same tag.

4. *Camptoptera pulla* species nova.

Female.—Length, 0.84 mm. Minute.

General color uniformly greyish black (near cologne earth); scape, pedicel, 1st funicle joint (less so) and legs (including at least the intermediate coxae, the others not visible) all pale clay yellow; remaining antennal joints concolorous with body, the first funicle joint intermediate in color, dusky yellow; eyes and ocelli dark red; usual vertexal carina present; thorax longer than abdomen, the latter subnapiform, widest and acute at proximal third and narrowing gradually to a point caudad, and truncately oblique to the petiole, cephalad; petiole short, acutely produced or barbed laterad just caudad of its center and with a small circular whitish dot in the middle of its dorsal aspect at base. Body apparently impunctate. Legs normal, the tarsal joints subequal, the proximal tarsal joint not much longer than any of the others, but subequal to them. Wings normal, longer than body; fore wings hyaline, slightly fumated near base, and with a slight but usual dilatation along the caudal margin at proximal fourth, curved at the apical fourth, and with moderately long marginal fringes which have the usual clear path around the edge of the wing at apex; discal cilia numerous, about from 3 to 4 longitudinal rows; venation dusky, inconspicuous; apical margin of

fore wing more pronounced. Hind wing fumated throughout, its petiole yellowish; curved at about its center, linear, and with at least two longitudinal rows of discal cilia, very close together and central. Ovipositor very slightly exserted.

Antennae 9-jointed; scape curved, normal, longer than pedicel, the latter ovate, with the apical end truncate and serrated, and but two-thirds the length of the first funicle joint. Funicle joints 1–3 cylindrical, linear, 1 one-third shorter than 2 which is longest, subequal to the scape, and twice the length of funicle joint 3, the three joints filiform; funicle joints 4–6 cylindrical oval, wider, subequal in length but 4 is somewhat longer than the others, which, however, are somewhat wider than that joint; funicle 4 subequal in length to joint 3, joints 5 and 6 each becoming slightly shorter; club long, undivided, cylindrical ovate, longer than scape or funicle joint 2, and about equal the combined lengths of the three apical funicle joints. Setae present, but not very numerous and minute. Antennae longer than the body. (Fig. 2. Flagellum of female, the setae omitted. The club is a little too long in the drawing.)

Fig. 2. Flagellum of *Camptoptera pulla* Girault, female greatly enlarged.

(From two specimens, 2–3 inch objective. Bausch and Lomb.)

Male.—Unknown.

Described from two females mounted in balsam and collected on a window in a woodshed, Urbana, Illinois, July 15 and 17, 1908 (J. Douglas Hood.) Several other specimens were observed July 17, 1908, on the same window suspended in a spider's web, but because of their minuteness were lost.

Type.—Accession No. 39116, Illinois State Laboratory of Natural History, Urbana, Illinois, 1 ♀ in balsam.

This species resembles closely in structure of the antennal joints, the wings, and that of the body, the type of the genus, Foerster's *papaveris* but differs markedly in coloration, (*papaveris* being almost uniformly colored), in the number of discal cilia of the fore wings, in the fumation of the hind wings, in the longer, slenderer club, and in its habitus.

TABLE OF THE SPECIES.

A. Species yellowish brown, color uniform.
Joint 2 of the funicle the longest funicle joint; scape about as long as the combined lengths of the two following joints; fore wings with but a single prominent row of discal cilia ..... **papaveris**

B. Species more or less black.
a. Shining black.
Antennae and legs "jaune–orange" ..... **clavata**
Antennae black, excepting basal three-fourths of the scape: legs brown, excepting coxae; joint 4 of funicle the longest funicle joint; scape about as long as the three following joints; fore wings with 4 longitudinal rows of discal cilia ..... **metotarsa**
b. Greyish black.
Antennae concolorous, excepting first three joints, which together with the legs, are pale clay yellow. Joint 2 of the funicle the longest funicle joint; scape not quite as long as the combined lengths of the pedicel and first funicle joint..... **pulla.**

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"784. **G. Camptoptera** Först. (**Pteroclisis** Först. Hym. Stud. II 144.)

1. C. PAPAVERIS Forst. Aachen. Aus Gallen V. Aulex rhoeadis."

1873. Snellen van Vollenhoven, S. C. Schetsen ten gebruike bij de Studie der Hymenoptera, 'S Gravenhage (Uitgegeven door de Nederlandsche Entomologische Vereeniging), 1869–1873, IV, Proctotrupiden, tabel XIII, Camptoptera Först.

Enlarged profile pen-drawing of the female *Camptoptera* (evidently the species *papaveris* Foerster), with enlarged male antenna. The details are incorrect for the female and as the work as a whole has been discredited, it may be assumed that the details of the male antenna are as well nonreliable.

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STUDIES ON APHIDIDÆ. II.*

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The Birch Callipterus.

[*Callipterus betulæcolens* (Fitch) Monell.]

What is supposed to be this species was first described by Asa Fitch in his "Catalogue of the Homoptera of New York" in 1851 as *Aphis betulæcolens*. Monell described it from Missouri as *Callipterus betulæcolens*, n. sp., and placed *Aphis betulæcolens* of Fitch as doubtfully synonymous. Thomas hesitatingly placed this species and *Calaphis betulella* as *Callipterus betulæ* of Koch, but there is little doubt that all three are distinct species. Oestlund redescribed the winged viviparous female, from specimens collected in Minnesota, as *C. betulæcolens* (Fitch), and gave *C. betulæcolens* of Monnell as synoynmous. It has been further reported in the literature by Miss Edith M. Patch from Maine, and by W. T. Clarke from California.

In Illinois I have found it a very common species on *Betula alba*, and it doubtless occurs wherever the birch is found. It became very abundant this fall (1908), especially at the time the sexual forms appeared.

The viviparous females were found on birch throughout the summer and as late as September 28, at Chicago, Illinois. The oviparous females, winged males, and eggs were first noticed September 21, 1908, and at that time many pairs were observed *in copula*. Careful observations were made to determine whether or not the hind tibiæ of the oviparous females, which in this species always bear sensoria, played any part in copulation or oviposition, it having been stated by R. A. Vickery ("A Comparative Study of the External Anatomy of Plant Lice." p. 11. Separate of the Twelfth Report of the State Entomologist of Minnesota, 1908) that the hind tibiæ of oviparous female aphids have some function in connection with oviposition. The hind tibiæ of the oviparous females of this species, however, played no part whatever in oviposition, nor, so far as could be observed, in the act

* For No. 1 of this series see the Annals of the Entomological Society of America, Vol. I, No. 4, December, 1908, pp. 251–264.

of copulation. During the period of oviposition the females wander along the branches in search of suitable places on which to deposit eggs. Upon finding such places—for example, a crevice formed by a dormant bud or a small crotch where two small branches or twigs unite—she extends the tip of the ovipositor into the crevice and deposits the egg as far into it as possible. This process requires from three to five minutes. Usually the female seeks another part of the branch soon after laying the egg, but seldom lays a second egg immediately. One individual which had just oviposited was examined, and eight more well-developed eggs were found in her body.

DESCRIPTIONS.

Winged viviparous female.—The description of the winged viviparous female by Monell and Oestlund are quite complete, and further descriptions are unnecessary except for the few remarks following: The basal two thirds of antennal segment III bears 8 to 14 circular sensoria in a row. Usually the number is 12 or 13, and the extremes 8 and 14 are exceptions. Figure of the antenna is given in plate V, figure 1.

Wingless oviparous female.—Head pale whitish yellow. Prothorax pale greenish yellow with a longitudinal brownish stripe on each side. The remaining thoracic segments like the first except that the lateral marking, which continues on these segments, changes to a decided green. Abdomen yellowish with a slight greenish tint, and sometimes the orange-colored eggs show through the body, giving it an orange tint. The lateral thoracic stripes continue along the sides of the abdomen, widening on one of the anterior segments, but continuing posteriorly to the cornicles as a narrow stripe. Immediately anterior to the cornicles is a transverse band of a brownish green color, which connects the green lateral markings. Posterior to the cornicles the abdomen is pale greenish yellow, with no noticeable markings. Sometimes the green markings above described are very indistinct, and the abdomen, in this case, is of a cream yellow color.

Head with slight frontal tubercles and a more or less conspicuous tubercle on the front bearing the median ocellus, six moderately long capitate hairs projecting cephalad from the front, and one on each side of the dorsum of the head at the base of the frontal tubercles. (Pl. V, fig. 2.) Antennæ longer than body, usually about one and one half its length, segment III longest, being twice the length of V, IV subequal with filament of VI, V about twice the length of the base of VI, VI (base and filament) slightly less than III and the filament slightly more than twice the basal portion; distal halves of III and IV with weak imbrication, distal half of V and all of VI with slightly stronger imbrication, distal half of V and all of VI with slightly stronger imbrication; an occasional minute capitate hair (Obj. 1–6) on the basal half of the antennæ; 1 to 7 (usually 2 to 4) sensoria near the base of segment III. (Pl. V, fig. 3.) Segments I and II concolorous with head, III, IV, V, and base of VI with the basal halves whitish yellow and the distal halves blackish, filament of VI entirely black. In older specimens the antennæ are entirely black excepting I, II and a small portion at basal end of each of the remaining segments. Beak not reaching beyond the coxæ of the second pair of legs. Eyes red. Legs with femora pale yellowish, tibiæ brownish excepting distal ends which are black, and the tarsi black. Hind tibiæ with the basal half noticeably swollen and bearing 75 ar 80 small, more or less circular, and irregularly placed sensoria, most of which are borne on the inner surface. (Pl. V, fig. 4.) Abdomen with a transverse row of 6 or 8 tubercles on each segment, each tubercle bearing a single moderately long capitate hair. Cornicles typical of the genus, and of a pale greenish yellow color. (Pl. V, fig. 5.) Style concolorous with the cornicles, short and rounded at the apex

(unlike the style of the viviparous female in that there is no constriction near the base), and 12 to 15 hairs projecting caudad. (Pl. V, fig. 6.) Anal plate larger than the style, similarly rounded, and with numerous hairs over its surface. (This differs from the anal plate of the viviparous female in that it is not divided or bifid.)

Measurements [taken from 10 specimens (Chicago, Ill., September 21, 1908) mounted in balsam].—Length of body 2.00–2.54, av. 2.28 mm.; width, 0.82–1.21, av. 0.97 mm.; antenna, I, 0.13; II, 0.065; III, 0.92–1.06, av. 0.98; IV, 0.54–0.67. av. 0.60; V. 0.42–0.50, av. 0.47; VI, base, 0.23–0.27, av. 0.25; VI, filament, 0.52–0.65; av. 0.61; total average, 3.105 mm.; cornicles, 0.126 mm.; style, 0.10 mm.; hind tarsus, 0.16 mm.

Winged male:—The males are similar to the winged viviparous females but they may be easily distinguished from them as follows: Antennal segment III of male with one third to one half more sensoria than the equivalent segment of the female antenna, and they extend the entire length of the segment in the former while in the latter these sensoria are found only on the basal two thirds. Further, the abdominal segments of the male have short transverse bands on the dorsum, these being absent on the abdomen of the winged viviparous female.

(Described from winged males collected *in copula*, at Chicago, Ill., September 21 and 28, 1908.) Head pale greenish with more or less of a brownish tint, in a few cases dusky; with noticeable frontal antennal tubercles; the medial ocellus prominent and projecting beyond the fore border. Antennæ nearly bare; 24–28 transverse (usually a few are circular) sensoria in a row the entire length of III, the usual large elongate sensorium at end of V and a similar one, with several smaller sensoria bordering it, at distal end of the basal portion of VI; nearly twice the length of the body, III the longest, being one third longer than IV, IV usually slightly longer than filament of VI, often IV and filament of VI subequal and occasionally the latter slightly the longer, V one half or slightly more than one half of III, base of VI one third to one fourth the length of filament of VI and together they are longer than IV but shorter than III. (Pl. V, fig. 7.) Segments I and II pale greenish, III dusky or brownish at base, the distal half darkening to black, IV black excepting basal one third which is pale or dusky, V and base of VI black except the basal thirds of each, which are whitish, filament of VI black. Eyes red. Beak not reaching to coxæ of second pair of legs. Prothoracic segment pale greenish with an almost square brown marking on the median dorsum. Thoracic shield dusky brown. Wings hyaline, basal two thirds of the stigmal vein subobsolete, stigma pale, costal and subcostal veins pale brownish, remaining veins blackish, and a small dusky brownish area at the end of each vein except the costal and subcostal, and usually the first and second anal. (Pl. V, fig. 8.) The first and second discoidals branching at about one half the distance from the margin to the third discoidal. Legs with femora pale brownish, tibiæ black at extremities and brownish in the middle, tarsi entirely black. Abdomen pale yellowish green with a median longitudinal black marking on the dorsum, consisting of short transverse bands ending on the antepenultimate segment. A longitudinal row of fine hairs on the dorsum extending along the outer portion of the black patch (two hairs to each segment, one on each side), a very small pale area at the base of each hair (in specimens mounted in balsam). Cornicles and style pale yellowish green in color and characteristic of this genus.

Measurements [from 10 specimens mounted in balsam, collected at Chicago, Ill., September 21 and 28, 1908]:—Length of body, 1.36–1.86, av. 1.61 mm.; width, 0.52–0.68, av. 0.57 mm. (at base of cornicles the average width is 0.46 mm.); length of wing, av. 3.00 mm.; width, av. 0.93 mm.; wing expanse, approx. 6.50 mm.; antenna, I, 0.13; II, 0.065; III, 0.83–1.08, av. 0.93; IV, 0.56–0.70, av. 0.64; V, 0.44–0.54, av. 0.50; VI, base, 0.18–0.24, av. 0.21; VI, filament, 0.54–0.69, av. 0.62; average total, 3.095 mm.; cornicles, 0.09 mm.; hind tarsus, 0.16 mm.

Egg:—Pale orange when first laid, and later changing to jet black.

The European Linden Callipterus.

[*Callipterus* (*Eucallipterus*) *tiliæ* (Linn.)]

This beautiful aphid I found to be common on the European and American lindens in Chicago parks and in several nurseries in the vicinity of that city. I have been unable to find any reference to this species as having been found in this country, but Mr. J. T. Monell writes that he received specimens of this species from Mr. Theo. Pergande, which were taken on linden at Washington, D. C., May 26, 1886.

This species was first described by Linnæus as *Aphis tiliæ* and has since been placed in *Callipterus* by Koch, in *Pterocallis* by Passerini, and recently in *Eucallipterus* by Schouteden. Owing to lack of literature I have been unable to compare the synonymy of this genus, and have therefore accepted that given by Schouteden. Likewise the original description of the genus *Pterocallis* is unavailable, but in *Aphididæ Italicæ*, Passerini says of the genus: "Antennæ articulo septimo breviore, cæterum ut Myzocallis." The characters given for this genus by Buckton all agree with those of the genus *Callipterus*, with the possible exception of the triangular fuscous patches at the ends of the veins. The length of the filament of the sixth antennal segment, which is used in separating *Pterocallis*, is an uncertain character, and of no generic value in itself, for the length of this portion of the sixth segment may vary from an extremely long filament, as in *Callipterus betulæcolens*, to one subequal to the basal portion as in *C. trifolii* Mon.

Mr. Monell has called my attention to a note by Buckton which illustrates the instability of the genus under discussion. Under *Pterocallis juglandicola*, Buckton* says: 'On account of the size of the seventh antennal joint, possibly this species might be ranged under *Callipterus;* I leave it, however, where Passerini has placed it." Although *C. tiliæ* differs slightly from the typical *Callipterus*, it does not seem sufficiently characterized for a separate genus, and I therefore retain the genus *Callipterus* with *Eucallipterus* as a possible subgenus.

The habits of this species agree in every respect with those of the genus *Callipterus*. This year (1908) the sexual forms were found as early as September 15.

* Buckton, G. B. Monograph of the British Aphides, London, Vol. III, 1880, footnote, p. 33.

DESCRIPTIONS.

Winged viviparous female (from specimens collected in Chicago, Ill., July 23, 1908):—Head pale yellow, with a blackish line on each side connecting with the thoracic markings described later. (Pl. VI, fig. 19.) Antennæ black excepting the whitish basal halves of IV, V, and basal VI, a short area at middle of III, and the filament of VI dusky; 10 to 16 transverse sensoria on the basal half of III, one circular sensorium near apex of V and another at the apex of the basal half of VI, around which are several smaller sensoria. All segments, especially the distal ones, with strong imbrications which completely encircle the antennæ, giving them the annulated appearance common in the antennæ of *Schizoneura, Tetraneura*, etc. Entire length slightly more than that of the body, III longest, it being one third longer than IV, which is slightly longer than, or subequal to, V, VI (base and filament) very little longer than IV, and the base of VI somewhat larger than the filament. (Pl. V, fig. 9.) Eyes bright red. Beak reaching slightly beyond the coxæ of the first pair of legs. Prothorax pale yellow and the remainder bright yellow. A very conspicuous black stripe extends along each side from in front of the eyes to the base of the wings. When the wings are in a resting position the black costal area on the wings gives the appearance of a continuous black lateral line the entire length of the body. The mesothorax also bears a brownish longitudinal marking on each side of the median dorsal. Wings hyaline, the costal area from the base to the stigma brownish to black, the stigma similarly colored excepting a patch on the outer margin, and a brownish triangular patch at end of each vein; first and second discoidals branching at about two fifths the distance from the tip of the wing to where the third branches. (Pl. V, fig. 10.) Two fore pairs of legs pale excepting the tarsi, which are black. Hind pair pale excepting the black femora and tarsi, the femora with about 15 or 20 pale circular areæ which look very much like the sensoria of the antennæ when seen through a low objective, but with a 1–6 objective they are found to be of hypodermic origin. (Pl. V, fig. 11.) Abdomen pale yellow, with two longitudinal rows of brown black spots on each side of the median dorsal line, the row nearest the median line consisting of 8 spots and the other row with 2 to 5 spots. Cornicles pale yellow with a fine, almost indistinguishable, dark apical margin, tuberculate in shape, and about one third the length of the hind tarsus. (Pl. V, fig. 12.) Style concolorous with cornicles, globular and often with the "neck" barely constricted; 15 or 20 fine tuberculate hairs projecting caudad. (Pl. V, fig. 13.) Anal plate decidedly bifid.

Measurements [taken from 12 specimens mounted in balsam]:—Length of body, av., 1.97 mm.; width, av. 0.61 mm.; length of wing, av., 2.65 mm.; width, 0.895 mm.; wing expanse, approx., 6 mm.; antenna, I, 0.08; II, 0.065; III, 0.64–0.74, av., 0.68; IV, 0.41–0.49, av., 0.44; V, 0.37–0.45, av. 0.41; VI, base, 0.26–0.32, av. 0.28; VI, filament, 0.195–0.245, av., 0.215; average total, 2.17 mm.; cornicles, 0.057 mm.; style, 0.145 mm.; hind tarsus, 0.155 mm.

Wingless viviparous female:—I have never been able to find wingless viviparous females, though I have made careful searches for them. Buckton has described and figured what he calls the apterous viviparous female, but he does not state when this individual was collected, and the characters given are too incomplete to decide whether or not it is the viviparous, or whether it is the oviparous. I believe he has described the oviparous female under the head of apterous viviparous female, as his description compares exactly with the oviparous females which I have found in Illinois.

Wingless oviparous female [from specimens collected in Chicago, Ill., September 15 and October 8, 1908]:—Head black or brownish, sometimes with a pale median longitudinal line. (Pl. VI, fig. 20.) Antennal segments I and II, dusky, III, IV, V, and base VI pale at basal halves or two thirds, and black the remaining lengths, filament VI blackish; the usual sensorium at the end of V, and one at end of the basal portion of VI, which is surrounded by several smaller ones; imbrication slight on IV and V, but distinct on VI, although without the conspicuous annulations of the winged viviparous antennæ. (Pl. V, fig. 14.) Total length slightly less than that of the body; III, the longest, being

slightly less than VI and about a third greater than IV; IV and V subequal; basal VI less than V and greater than filament VI. Eyes red. Beak not reaching or barely reaching the coxæ of the second pair of legs. Prothoracic segment brownish to black, with a small yellowish area on each side of the median, and often with a threadlike pale median line. The coloration of the meso- and the meta-thorax the same as that of the abdomen described below. The two fore pairs of legs pale yellowish, excepting the dusky distal end of the tibiæ and the black tarsi; hind pair with the tibiæ, and distal halves of the femora dusky to black, and the tarsi black; hind tibiæ swollen and bearing about 35 irregularly placed, inconspicuous, circular sensoria on the basal halves. (Pl. V, fig. 15.) The two posterior thoracic and the abdominal segments with a black transverse band on each side of the median line, and a black spot on each side; the interspaces yellow. The anterior dorsal bands necessarily shorter and the bands on segments 5, 6 and 7 uniting in the middle, thus forming a single transverse band on each of these segments. The position of the dorsal markings is well illustrated by Koch in "Die Pflanzenläuse," figure 283. Cornicles blackish and tuberculate as those of the viviparous female. Style pale yellowish. At base of each cornicle and beneath the body, on each side, is a very noticeable silvery white spot, which disappears on specimens mounted in balsam, the same areæ on the undersides of such specimens being represented by a brownish spot.

Measurements [from 8 specimens mounted in balsam]:—Length of body, 2:00 mm.; width, 0.89 mm.; antenna, I, 0.08; II, 0.065; III, 0.41–0.50, av., 0.44; IV, 0.23–0.30, av., 0.27; V, 0.24–0.30, av., 0.275; VI, base, 0.17–0.23, av. 0.20; VI, filament, 0.14–0.185, av. 0.165; average total, 1.495 mm.; style, 0.145 mm.; hind tarsus, 0.15 mm.

Winged male:—The male may readily be distinguished from the winged viviparous female by its smaller size and by the sensoria on the antennæ. The antennæ of the female bear sensoria only on the basal halves of III, and the usual ones at the distal ends of V and base VI, while the male antennæ bear them on every segment excepting I and II. (Described from specimens collected at Chicago, Ill., September 15 and October 8, 1908.) Head usually dark brownish to blackish excepting a more or less triangular yellowish area at the posterior portion; sometimes, however, the yellowish area extends to the fore border of head. Antennæ black excepting the pale dusky filament of VI and the extreme base of all segments beyond III; annulations as on the antennæ of the winged viviparous female; total length a little more than that of the body, III the longest, and slightly less than twice IV, IV and V subequal, VI about two thirds III, and the base VI longer than the filament; 30 to 38 transverse sensoria placed more or less in a row the entire length of III, 6 to 9 on IV, 7 to 9 on V, 3 to 5 on base of VI, and the usual one at distal end of the same. (Pl. V, fig. 16.) Eyes red. Beak not reaching the base of the coxæ of the second pair of legs. Prothorax yellowish with the typical black lateral stripe which extends from the eyes to the base of the wings. Thoracic shield brownish to blackish. Wings as those of the viviparous female, except that they are smaller. Fore pair of legs yellowish or slightly dusky, with the tarsi black, hind pair with the femora, bases of tibiæ, and tarsi blackish, and the middle pair usually intermediate between these two types of coloration; the middle and hind femora usually with the clear circular areæ referred to in the description of the viviparous female. Abdomen pale yellowish green, with a row of short, transverse, blackish markings on either side of the median dorsal line, and a partial row of dots on each side. Cornicles dusky and tuberculate as in the other forms. Style yellowish or with a slight duskiness.

Measurements [taken from six specimens mounted in balsam]:—Length of body, 1.42 mm.; width, 0.56 mm.; length of wing, 2.41 mm.; width, 0.87 mm.; expanse, approx., 5.50 mm.; antenna, I, 0.08; II, 0.065; III, 0,60–0.66, av. 0.63; IV, 0.34–0.37, av. 0.36; V, 0.32–0.39, av. 0.35; VI, base, 0.21–0.26, av. 0.23; VI, filament, 0.14–0.21, av. 0.17; average total, 1.885 mm.; cornicles, 0.05 mm.; style, 0.10 mm.; hind tarsus, 0.13 mm.

The Tulip-tree Aphid.

(*Macrosiphum liriodendri* Monell, and var. *rufa* Monell.)

Macrosiphum liriodendri is not an uncommon species in Illinois, occurring on *Liriodendron tulipifera*, and has been observed in the vicinity of Urbana for the past two years.

It was first described by Mr. J. T. Monell from Missouri, and has since been reported from Washington, D. C., by Dr. L. O. Howard, who noted that the eggs were common in the pupal shells of Cicada which were attached to the tree trunks.

In Illinois, the eggs, which were first found the middle of October (1907), are laid in crevices, usually between the buds and the branch. The following spring the eggs began to hatch between March 29 and April 3, the young at this latter date being of the first instar. The entire yearly cycle is passed on the tulip tree.

The variety *rufa* Monell was first observed July 6, intermixed with the normal form in colonies and about equaling the latter in abundance.

DESCRIPTIONS.

Winged viviparous female:—The original description by Monell* is sufficiently complete except for a few minor points, but owing to the fact that this is the only description published of the tulip tree aphid, and that it is inaccessible to many workers, I will redescribe it from Illinois specimens.

Head pale greenish yellow or dusky; with conspicuous frontal antennal tubercles, and the median ocellus projecting beyond the fore margin. (Pl. VI, fig. 21.) Antenna black excepting the two basal segments, which are dusky green; 14–18, circular sensoria in a row on III, the usual conspicuous one at the distal end of V, and one large one with several smaller ones surrounding it at the apex of base VI; more than one half longer than the body, III, IV and V subequal, but III always slightly longer than either IV or V, VI the longest, being nearly twice V, base VI about one fourth the length of V, filament VI long and setaceous. (Pl. VI, fig. 22.) Eyes black. Ocelli dark red and rather conspicuous. Beak barely reaching the coxæ of the second pair of legs. Thorax brownish. Wings hyaline with dark brown veins, the first and second discoidals branching at a distance less than one half from the margin to where the third discoidal branches. (Pl. VI, fig. 23.) Legs black, excepting the basal four fifths of the femora, which portion is pale greenish. Abdomen pale green. Cornicles black excepting the extreme base, which is pale greenish; reaching beyond the tip of the abdomen, and three to three and one half times the length of the style; slightly incrassated at the base and barely noticeably dilated near the apex; distal end distinctly imbricated. (Pl. V, fig. 17.) Style pale greenish yellow, ensiform, decidedly uncurved, and about one half longer than the hind tarsus. (Pl. V, fig. 18.)

Measurements [from five specimens mounted in balsam]:—Length of body, 2.25 mm.; width, 0.77 mm.; length of wing, 3.35 mm.; width, 1.18 mm.; expanse, 7.50 mm.; antenna, I, 0.135; II, 0.07; III, 0.64–0.82, av. 0.74; IV, 0.66–0.77, av. 0.705; V, 0.70–0.74, av. 0.715; VI, base, 0.175; VI, filament, 1.09–1.26, av. 1.17; average total, 3.70 mm.; cornicles, 0.85 mm.; style, 0.26 mm.; hind taruss, 0.16 mm.

* Notes on the *Aphididæ* of the United States, with descriptions of species occurring west of the Mississippi. U. S. Geol. and Geog. Survey of the Territories, Vol. V, No. 1, pt. II, p. 20, 1879.

Wingless viviparous female:—Head pale green and with frontal tubercles as on winged. Antenna black excepting segments I and II, and a small basal portion of III, which are pale green or slightly dusky; the usual sensoria on V and VI (one exceptional specimen has 3 and 4 sensoria, respectively, on each antenna near the base of III); total length about one half greater than that of the body, segment III about one fourth longer than IV, IV and V subequal, VI the longest, and slightly less than IV and V together, base VI about one fourth the length of V, filament VI setaceous and about one half longer than III (a single exception, not recorded in measurements below, has III and filament VI subequal). (Pl. VI, fig. 24.) Eyes black. Beak reaching to or sligtly beyond the coxæ of the second pair of legs. Thorax pale green, with a very slight pulverulence. Legs pale green except the bases and apices of tibiæ, which areas are dusky to black, and the tarsi which are black. Abdomen concolorous with, and bearing a similar pulverulence as, the thorax. Ventral surface of body with the whitish pulverulence or bloom more conspicuous. Cornicles black except the bases, which are pale, similar in shape to those of the winged female, and about two and a half times longer than the style. Style pale green, ensiform, and about twice the length of the hind tarsus.

Measurements [from specimens mounted in balsam]:—Length of body, 1.75–2.50 mm.; width, 0.72–1.07 mm.; antenna, I, 0.13; II, 0.07; III, 0.73; IV, 0.60; V, 0.61; VI, base, 0.16; VI, filament, 1.07; average total, 3.37 mm.; cornicles, 0.71 mm.; style, 0.29 mm.; hind tarsus, 0.15 mm.

Immature:—Dull green with blackish legs, antennæ, cornicles, and eyes.

Wingless viviparous female, variety *rufa*:—I have found only the wingless forms of this red variety. It is identical in form and measurements with the normal form of the wingless viviparous female, and is only distinguished from the latter by its coloration.

Head, thorax, and abdomen of a decidedly rosy tint. The ventral surface pale reddish, and covered with a whitish pulverulence or bloom. Antennal segments I and II pale, III pale at base and gradually darkening to black, remaining segments black. Eyes black. Coxæ pale reddish, otherwise legs as in normal form. Cornicles black, excepting at bases which are pale. Style pale with a reddish tint.

Wingless oviparous female:—The only structural character distinguishing this form from the wingless viviparous female is the presence of numerous sensoria on the hind tibiæ. General color pale greenish, the abdomen with a yellowish tint. Notes of the individual colorations of the body and appendages have been lost or misplaced, but in general they agree with those of the wingless viviparous female. The antenna is a little less than one and one half times the length of the body, III slightly longer than IV, IV and V subequal, VI the longest, being subequal to IV and V together, base VI about one sixth or less the length of the filament, which is one and one half times III; sensoria absent excepting the usual ones at the distal ends of V and base VI. (Pl. VI, fig. 25.) The basal half of the hind tibiæ swollen and bearing 50 to 70 small circular sensoria. (Pl. VI, fig. 26.)

Measurements [from specimens in balsam and alcohol]:—Length of body, 1.97–2.47 mm.; width, 0.82–1.07 mm.; antenna, I, 0.125; II, 0.065; III, 0.52–0.65, av. 0.59; IV, 0.42–0.59, av. 0.505; V, 0.42–0.59, av. 0.51; VI, base, 0.15; VI, filament, 0.92–1.02, av. 0.95; average total, 2.89 mm.; cornicles, 0.60 mm.; style, 0.22 mm.; hind tarsus, 0.145 mm.

Winged male [from specimens in balsam and alcohol]:—Distinguished from the viviparous female by its smaller size and the numerous sensoria on antennal segments III, IV and V.

Coloration similar to the winged viviparous female, excepting the usual presence of a faint row of dusky to blackish dots on each side of the abdomen. Head and appendages (excepting the antennæ) similar in shape and markings to those of the winged female. Antennæ about one and one half times the length of the body, III about one half VI, IV and V subequal, basal VI about one fourth V, filament VI equal to IV and V combined; 40 to 53 circular sensoria irregularly placed on one side of III, 22–27 more or less in a row on IV, 15–21

in a row and the usual larger one at distal end of V, a single large sensorium with several smaller ones near its border, at distal end of base VI. (Pl. VI, fig. 27.) Wings with the first and second discoidals branching slightly nearer to the margin than in the viviparous female, this character being more variable in the latter.

Measurements [from specimens in alcohol and balsam]:—The measurements for different individuals differs considerably in some cases, but the comparative lengths are quite constant. Length of body, 1.79–2.36 mm.; width, 0.61–0.89 mm.; length of wing, 2.61–3.29 mm.; width, 0.98–1.18 mm.; expanse, 5.75–6.50 mm.; antenna, I, 0.11; II, 0.07; III, 0.56–0.75, av. 0.67; IV, 0.44–0.63, av. 0.53; V, 0.47–0.59, av. 0.535; VI, base, 0.13–0.145, av. 0.14; VI, filament, 0.99–1.26, av. 1.12; average total, 3.175 mm.; cornicles, 0.55 mm.; style, 0.22 mm.; hind tarsus, 0.15 mm.

Egg:—Pale greenish or greenish yellow when first laid, and later changing to jet black. Elliptical oval, measuring 0.64 mm. in length and 0.31 mm. in width.

The Ornamental Currant Macrosiphum.

(*Macrosiphum cynosbati* Oestlund.)

The winged form of *Macrosiphum cynosbati* was first described by Professor Oestlund, it having been collected in Minnesota in 1887 on *Ribes cynosbati*. It has not since been reported in the literature as occuring elsewhere.

This year (1908) it was very common and in some localities quite injurious to the ornamental currants in Chicago parks. It did not appear in injurious numbers until the first of August, at which time only the wingless forms were present, and these densely colonized the tender terminal twigs, infesting all parts, but particularly tips of the twigs, or, when present in abundance, the under sides of the leaves also, and in sufficient numbers to curl them more or less. Winged forms were first found in these colonies September 3. Usually either the common brown ant (*Lasius niger* var. *americanus*) or the black ant (*Formica fusca*) was in attendance upon the plant-lice.

The sexual forms of this species were first found on these same bushes October 5, at which time they were observed pairing.

DESCRIPTIONS.

Winged viviparous female [from specimens collected in Chicago, Ill., August 10, and September 3 and 11, 1908]:—Head dusky with distinct and approximate frontal antennal tubercles and 6 or 8 subcapitate hairs projecting cephalad from the fore border. Antennæ black, excepting the two dusky basal segments, and a fine pale ring on III at joint of II and III; sparsely covered with hairs which are more or less subcapitate; 30 to 43 tuberculate, circular sensoria, irregular in size and arrangement, placed the entire length of III, occasionally a single one on IV, the usual sensorium at the distal end of V and one at apical end of base VI with about 6 smaller ones beside it; total length about one half longer than the body, III almost twice longer than IV and a little more than one fourth shorter than VI, IV and V, subequal, IV usually very slightly the longer, base VI very short, it being subequal to I, filament VI about three times V. (Pl. VII, fig. 30.) Eyes dark red. Beak reaching slightly beyond the coxæ of the hind pair of legs. Thorax pale green excepting the shield, which is pale

brownish. Wings hyaline, with brownish veins, the first and second discoidals branching at one half or less the distance from the margin to where the third discoidal branches. (Pl. VII, fig. 31.) Legs pale green to the distal portion of femur, which is blackish, tibia pale brownish excepting the black apical end, tarsus black. Abdomen entirely pale bright greenish. Cornicles pale greenish, white at basal half, the distal portion changing to blackish; reaching beyond the tip of the abdomen and more than three times the length of the hind tarsus; cylindrical and slightly dilated at distal one third. (Pl. VI, fig. 28.) Style concolorous with abdomen, ensiform, and slightly less than one-half the length of the cornicles. (Pl. VI, fig. 29.)

Measurements [from alcoholic and balsam mounts, collected in Chicago, September 3 and 10, 1908]:—Length of body, 1.65 mm.; width, 0.61 mm,; length of wing, 2.65 mm.; width, 0.91 mm.; expanse, approx. 6.00 mm.; antenna, I, 0.08; II, 0.07; III, 0.55–0.77, av. 0.65; IV, 0.32–0.42, av. 0.35; V, 0.29–0.36, av. 0.32; VI, base, 0.08–0.09, av. 0.085; VI, filament, 0.83–1.09; av. 0.95; average total, 2.505 mm.; cornicles, 0.48 mm.; style, 0.20 mm.; hind tarsus, 0.14 mm.

Wingless viviparous female:—Head with about six subcapitate hairs projecting cephalad from the front. (Pl. VII, fig. 32.) Antennæ borne on the usual frontal tubercles; pale excepting segment VI and the distal portion of V; usually 15 to 26 circular sensoria, unequal in size and irregularly placed on III (this is a very uncertain character in this form, some antennæ bearing only 7 sensoria on III), and the usual ones at apical ends of V and base VI; longer than body, the comparative lengths of the separate segments as given for the winged viviparous female. (Pl. VII, fig. 33.) Eyes dark red. Beak reaching or extending slightly beyond the coxæ of the third pair of legs. Legs pale, excepting the distal ends of the tibiæ, and at the joints of the tibiæ and femora, which are dusky, and the tarsi which are black. Abdomen bright green. Cornicles pale excepting the tips, which are slightly dusky, and about four times the length of the hind tarsi. Style pale with a slight greenish tint, and about two fifths the length of the cornicles.

Measurements [from specimens mounted in balsam]:—Length of body, 1.90 mm.; width, 0.88 mm.; antenna, I, 0.095; II, 0.08; III, 0.61; IV, 0.35; V, 0.35; VI, base, 0.095; VI, filament, 0.89; average total, 2.47 mm.; cornicles, 0.61 mm.; style, 0.23 mm.; hind tarsus, 0.15 mm.

Wingless oviparous female:—Head pale yellowish or greenish yellow, bearing about six subcapitate hairs which project cephalad from the fore margin. Antennal segments I and II concolorous with the head or slightly dusky, the remaining segments dark to black; subcapitate hairs sparsely placed on all segments; 13 to 23 circular sensoria irregularly placed on III, and the usual ones at the apical ends of V and base VI: subequal to or slightly longer than the body, III one third longer than IV, IV and V subequal, VI the longest, being about three times V, the base VI about subequal to I. (Pl. VII, fig. 34.) Eyes dark red. Thorax pale yellowish. Legs pale excepting the distal ends of the tibiæ and femora, also the tarsi, which are blackish; the basal one third of the hind tibiæ swollen and bearing 30 or 40 irregularly arranged circular sensoria, placed on the inner surface. (Pl. VII, fig. 35.) Abdomen pale orange and usually with two or three yellowish spots which are the eggs showing through the semi-transparent body tissue. Cornicles pale excepting at tips, which are dusky, cylindrical, and sometimes slightly dilated at the distal third, subequal in length to segment III of the antenna. Style pale and about two fifths the length of the cornicles.

Maesurements [specimens mounted in balsam]—Length of body, 2.09 mm.; width, 0.92 mm.; antenna, I, 0.11; II, 0.08; III, 0.60; IV, 0.37; V, 0.33; VI, base 0.11; VI, filament, 0.88; average total, 2.48 mm. (An exceptional specimen had the following antennal measurements: III, 0.39; IV, 0.26; V, 0.26; VI, base, 0.08; VI, filament, 0.61 mm.); cornicles, 0.56 mm.; style, 0.23 mm.; hind tarsus, 0.15 mm.

Winged male:—Head brownish and with very small subcapitate hairs arranged as on wingless oviparous female. Antenna dark brown at the base, darkening to black at the apical portion; bearing subcapitate hairs which are less conspicuous than those on the antenna of the above described female; 20 to

35 (usually 30 to 35) circular sensoria, irregularly placed on III, 11 or 12 on IV, and 4 to 7 on V, with the usual larger distal ones on V and base VI; about one third longer than the body, III more than one half longer than IV, VI and V subequal but IV usually slightly the longer, VI the longest, it being about one half longer than the next longest segment (III), base VI subequal with I. (Pl. VII, fig. 36.) Eyes dark red. Beak reaching slightly beyond the coxæ of the third pair of legs. Thorax brownish. Wings as described for the viviparous female. Legs with femora pale greenish excepting the distal ends, tibiæ brownish excepting distal ends and tarsi black. Abdomen blackish (no color notes taken). Cornicles as in the other forms, the basal half pale greenish and the apical portion dusky to black. Style pale brownish.

Measurements [from specimens in balsam]:—Length of body, 1.61 mm.; width; 0.62; length of wing, 2.40 mm.; width, 0.86 mm.; expanse, approx. 5.25 mm.; antenna, I, 0.09; II, 0.075; III, 0.56; IV, 0.33; V., 0.28; VI, base, 0.08; VI, filament, 0.80; average total, 2.215 mm.; cornicles, 0.40 mm.

The Button Bush Aphis.

(*Aphis cephalanthi* Thomas.)

This species was first described by Thomas in 1877 from specimens collected in southern Illinois on *Cephalanthus occidentalis*. The only addition to the accounts of its distribution or life history is a single record by Mr. J. G. Needham* of its occurence on the button-bush at Lake Forest, Ill.

I have found it very abundant on the same species of shrub at Chicago, Ill., and Mr. J. T. Monell has kindly sent me authentic specimens collected by him at St. Louis, Mo. September 29, 1908, at Chicago, where the branches, especially the terminal shoots of the button-bush were completely covered with this aphid, and numerous eggs, which had been deposited without any seeming care as to location, were found on the branches.

DESCRIPTIONS.

Winged viviparous female:—Head black, rounded at frontal margin, and sometimes the median ocellus projecting slightly beyond the front. (Pl. VII, fig. 37.) Antenna blackish or black; 10–17 circular sensoria irregularly placed on III, usually 1–6 on IV, the usual one at the distal end of V and a single large one with several smaller ones about its margin, at distal end of base VI; total length about three fourths that of the body, III about one half greater than IV, IV and V subequal, VI the longest, being subequal to IV and V combined, base VI about one third III and filament VI subequal to III but invariably very slightly longer. (Pl. VII, fig. 38.) Eyes blackish with a barely perceptible reddish tint. Beak nearly reaching the coxæ of the hind pair of legs. Thorax black. Wings hyaline, with pale veins, the first and second discoidals branching at a point varying from one third to nearly one half the distance from the margin to where the third discoidal branches. (Pl. VII, fig. 39.) Legs pale brownish except at the joint of the tibia and femur, distal end of the tibia and the tarsus, all of which are black; the hind pair of legs usually has the distal half of the femur likewise black. Abdomen dark greenish brown to reddish brown; bearing a row of white pulverulent spots on each lateral margin; in well prepared balsam mounts a fleshy tubercle is seen on each side of each of the segments, anterior to that bearing the cornicles and likewise on the segment posterior to it; and a dark spot at base of each cornicle. Cornicles black, cylindrical, about one half longer than the style, and not reaching the end of the abdomen. (Pl.

* Psyche, Vol. 10, Feb. 1903, pp. 26, 27.

VII, fig. 40.) Style black, conical, an slightly longer than the hind tarsus. (Pl. VII, fig. 41.)

Measurements [from specimens in balsam]:—Length of body, 1.50–1.97 mm.; width, 0.70–1.14 mm.; length of wing, 2.37 mm.; width, 0.90 mm.; expanse, approx. 5.25 mm.; antenna, I, 0.065; II, 0.06; III, 0.30–0.34, av. 0.31; IV, 0.195–0.235, av. 0.22; V, 0.195–0.22, av. 0.205; VI, base, 0.095–0.115, av. 0.105; VI, filament, 0.29–0.365, av. 0.34; average total, 1.305 mm.; cornicles, 0.23 mm.; style, 0.15 mm.; hind tarsus, 0.135 mm.

Wingless viviparous female:—Entire body pulverulent. Head dark reddish brown. Antennæ blackish, comparative lengths similar to those of the winged viviparous female, the usual sensoria at distal ends of V and base VI. (Pl. VII, fig. 42.) Eyes blackish. Thorax concolorous with head. Legs pale brownish, distal third of the femora, end of tibiæ, and the tarsi black. Abdomen brownish red, with a dusky marking at base of each cornicle which sometimes extends across the abdomen. Cornicles and style blackish.

Measurements [from specimens in balsam]:—Length of body, 1.29 (shriveled —1.79 mm.; width, 0.68 (shriveled)—1.00 mm.; antenna, averages, I, 0.065; II, 0.06; III, 0.30; IV, 0.20; V, 0.17; VI, base, 0.10; VI, filament, 0.33; average total, 1.22 mm.; cornicles, 0.21 mm.; hind tarsus, 0.14 mm.

Wingless oviparous female:—Entire body more or less covered with a whitish pulverulence which is densest at the posterior end. In most specimens the pulverulence appears more distinct in four longitudinal rows of short transverse areas on the dorsum. Head blackish or blackish brown, darker than the thorax and abdomen. Antennae with segments I and II dusky; III pale brownish, IV darker, V and VI blackish; about one half the length of the body, III about one fourth longer than IV, IV and V subequal, VI the longest, it being nearly twice as long as III, base VI about one third shorter than V, filament VI subequal to IV and V combined; the usual sensoria at distal ends of V and base VI. (Pl. VII, fig. 43.) Eyes black. Thorax reddish brown to blackish brown. Legs brown, excepting distal ends of the femora and tibiæ, and the tarsi, which are blackish; hind tibiæ much swollen almost their entire lengths and each bearing approximately 80 more or less circular sensoria. (Pl. VII, fig. 44.) Abdomen concolorous with thorax and with a small blackish area at base of each cornicle; and fleshy tubercles along the sides as on the winged viviparous female. Cornicles black and nearly one and one half times the length of the hind tarsi. Style blackish and subequal in length to the hind tarsus.

Measurements [from specimens in balsam and alcohol]:—Length of body, 1.79–1.97 mm.; width, 0.93–1.00 mm.; antenna, averages, I, 0.05; II, 0.05; III, 0.20; IV, 0.165; V, 0.16; VI, base, 0.10; VI, filament, 0.27; average total, 0.995 mm.; cornicles, 0.19 mm.; style, 0.14 mm.; hind tarsus, 0.14 mm.

Winged male:—Readily distinguished from the viviparous female by its smaller size and the presence of several sensoria on segment V of the antenna.

Head black and similar in shape to those of the other forms. Antennæ black; 14–18 circular sensoria irregularly placed on III, 9–12 on IV, 4–7 and the larger distal one on V, and the usual one, with several smaller ones bordering it, at distal end of base VI; about one half the length of the body, III one third to one fourth longer than IV, IV and V subequal, VI about twice the length of III, base VI one third shorter than V, filament VI about twice V. (Pl. VII, fig. 45.) Eyes blackish. Thorax black. Wings hyaline, the first and second discoidals branching at two fifths to one third the distance from the margin to where the third discoidal branches. Legs blackish excepting the basal halves of the femora. Abdomen brownish to reddish brown, a dusky to blackish patch at the base of each cornicle. Cornicles and style black.

Measurements [from specimens in balsam and alcohol]:—Length of body, 1.18–1.50 mm.; width, 0.465–0.54 mm.; length of wing, 1.97 mm.; width, 0.76 mm.; expanse, approx., 4.50 mm.; antenna, averages, I, 0.05; II, 0.05- III, 0.21; IV, 0.155; V, 0.15; VI, base, 0.10; VI, filament, 0.29; average total, 1.005 mm.; cornicles, 0.12 mm.; style, 0.10 mm.; hind tarsus, 0.13 mm.

Egg:—Yellowish brown when first laid, changing to jet black within a day or so; elliptical-oval in shape, and measuring 0.31 mm. in width and 0.64 mm. in length.

EXPLANATION OF PLATES V, VI, VII.

Callipterus betulæcolens (Fitch) Monell.—Plate V, figs. 1–8.

Figure 1, antenna of winged viviparous ♀; 2, head; 3, antenna; 4, hind tibia; 5, cornicle; 6, style of wingless oviparous ♀; 7, antenna; 8, wing of winged ♂.

Callipterus (*Eucallipterus*) *tiliæ* (Linn.).—Plate V, figs. 9–16; Plate VI, figs. 19–20.

Figure 9, antenna; 10, wing; 11, hind femora; 12, cornicle; 13, style of winged viviparous ♀; 14, antenna; 15, hind tibia of wingless oviparous ♀; 16, antenna of winged ♂; 19, head of winged viviparous ♀; 20, of wingless oviparous ♀.

Macrosiphum liriodendri Monell.—Plate V, figs. 17–18; Plate VI, figs. 21-27.

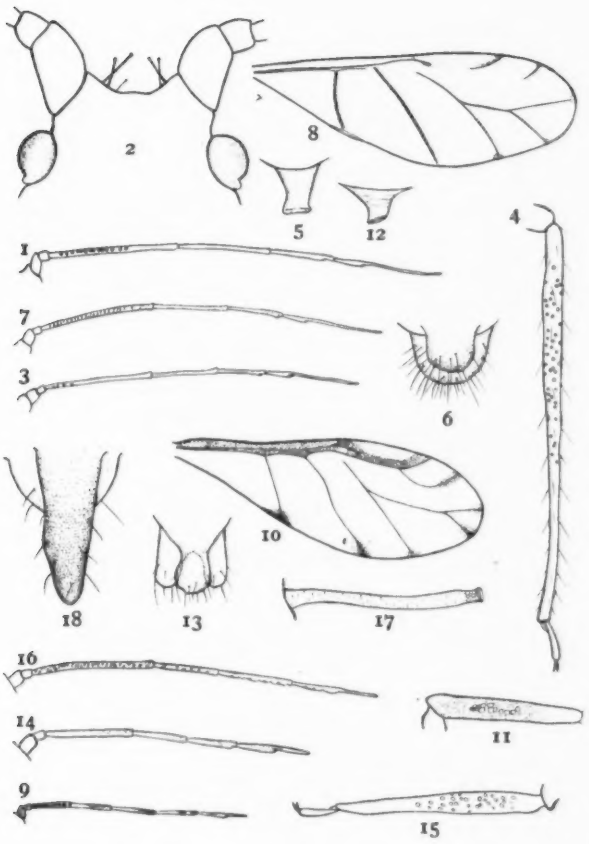
Figure 17, cornicle; 18, style; 21, head; 22, antenna; 23, wing of winged viviparous ♀; 24, antenna of wingless viviparous ♀; 25, antenna; 26, hind tibia of wingless oviparous ♀; 27, antenna of winged ♂.

Macrosiphum cynosbati Oestlund.—Plate VI, figs. 28–29; Plate VII, figs. 30-36.

Figure 28, style; 29 cornicle; 30, antenna; 31, wing of winged viviparous ♀; 32, head; 33, antenna of wingless viviparous ♀; 34, antenna; 35, hind tibia of wingless oviparous ♀; 36, antenna of winged ♂.

Aphis cephalanthi Thomas.—Plate VII, figs. 37–45.

Figure 37, head; 38, antenna; 39, wing; 40, cornicle; 41, style of winged viviparous ♀; 42, antenna of wingless viviparous ♀; 43, antenna; 44, hind tibia of wingless oviparous ♀; 45, antenna of winged ♂.



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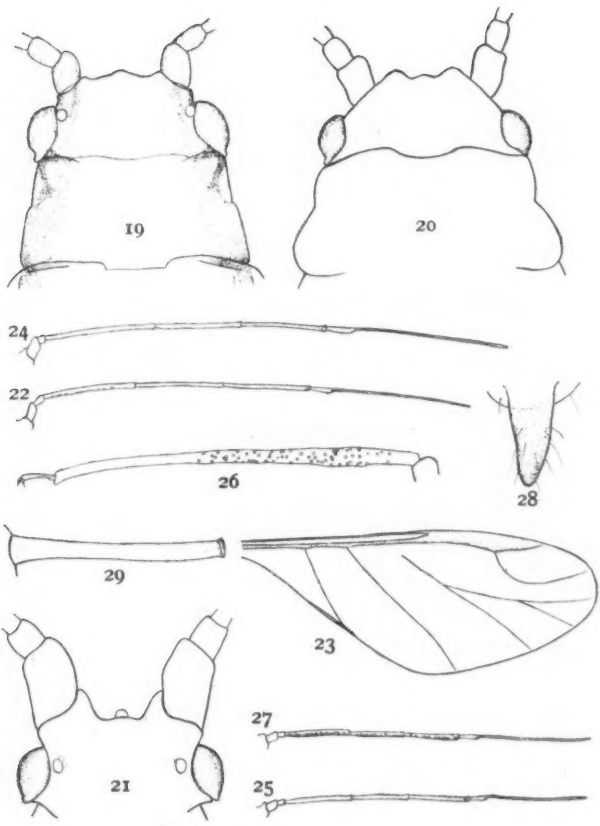

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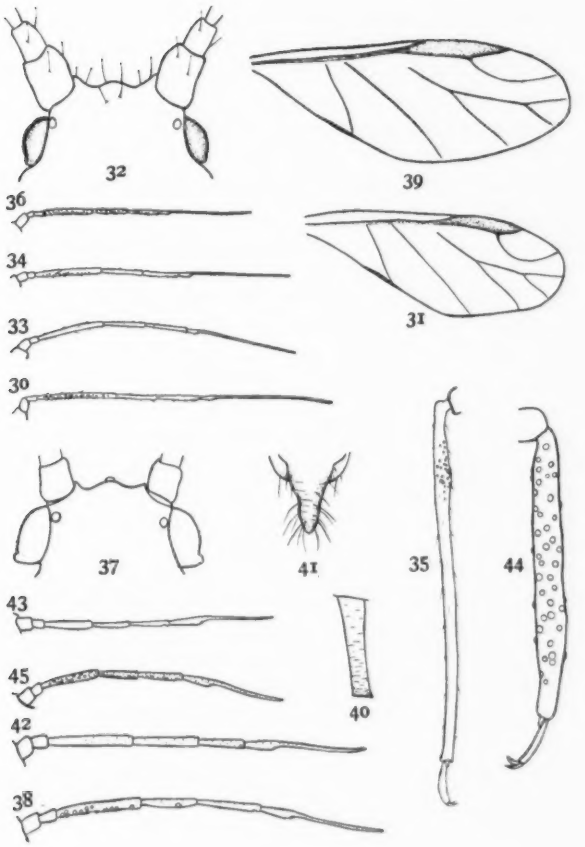

J. J. Davis.

THE TRACHEAL SUPPLY IN THE CENTRAL NERVOUS SYSTEM OF THE LARVA OF CORYDALIS CORNUTA L.

WILLIAM A. HILTON, Cornell University.

This study was begun with two main objects in view. First, to determine some land-marks for use in a study of the finer structure of the ganglia and nerve cells of this insect; and second, to determine the exact air supply of each ganglion for the purposes of later experimentation.

It is well known that all of the organs of insects are abundantly supplied with tracheae and many fine tracheoles, but the number and dense arrangement of the minute tracheoles in many of the organs comes as a surprise to the person who sees them under a microscope for the first time. The central nervous system is no exception to other organs, indeed the tracheoles are very abundant in all parts of the nervous system.

One of the disputed points in regard to the tracheae is the question whether the minute tracheoles anastomose with each other or not. They are very abundant, they branch to some degree and they are very long and wind and twist themselves into such a dense mat that it is very hard to follow individuals and hard to tell whether they unite or not.

There seems to be very little literature on the tracheal system of Corydalis. N. Young Burke, in an unpublished thesis in the library of the Department of Entomology of Cornell University, shows the main tracheae of the tracheal system of Corydalis. In her figures, ventral transverse tracheal branches running from side to side are shown. It is from these ventral transverse branches that most of the ganglia are supplied.

The subesophageal ganglion has two branches which come from the transverse ventral cephalic trachea and run to the cephalic part of the ganglion on either side. This ganglion is also supplied by two other branches, one on either side in its caudal region. These come from another source more caudad of the ganglion.

The three thoracic ganglia all receive two branches, one on each side from a ventral transverse trachea, which like the tracheal branch of the upper part of the subesophageal ganglion come to the ganglia from a cephalic direction.

The first to the seventh abdominal ganglia are supplied by one tracheal branch on each side, but these come to the ganglia from a caudal direction because the transverse tracheae in every case cross below or caudal to the ganglion to which they send branches. The transverse tracheae of the abdominal region except the first, are smaller as a rule than those of the thoracic region and the branches which run to the abdominal ganglia are often of considerable length.

The eighth abdominal ganglion is supplied from the outside by two long tracheal branches which come to it from the caudal direction.

The brain as described by Krauss '84, was found to be supplied by three lateral branches on each side from a common trunk.

The following pages will give a more or less detailed description of the tracheal supply in each of the ganglia of Corydalis.

For the larger branches ordinary dissection under a lens was the method of study. For finer details the entire central nervous system was removed and mounted in glycerine to which a drop of formalin was added. These mounts cleared up in a short time, the air in the finest tracheal tubes remained and they could easily be followed. No sections were studied at this time, but later, a large series of preparations will be examined with several objects in view, among them the determination if possible of how the finest tracheoles end.

THE BRAIN.

The brain is supplied by three main branches on each side, all of which come from a large cephalic tracheal branch. These three seem to be lateral portions from the large common trunk which runs forward somewhat reduced to supply other parts of the head.

The three trunks on each side, furnish each lateral half with all of its main tracheal branches. (Fig. A and 2.) There are comparatively few tracheae that cross the middle line and most of these are small. These three main portions enter the brain by their branches laterally from the ventral side and the description of them will be given as though they were seen from the ventral side.

The most cephalic part is the smallest and the most caudal the largest as a rule. Each part has both superficial and deep branches, and although the territories of the divisions overlap to some degree, the areas supplied by each are somewhat as follows:

(1) *Cephalic branch*, dorsal and lateral portion including branches that go to the optic nerves. It divides into two main parts before entering the brain, a cephalic smaller branch which divides into a number of long tracheae, many of them superficial and supplying the latero-cephalic portion of the brain. The larger more caudal part of four or more rather large branches, for the most part deep ones which supply the central part of the brain and to some extent the other side.

(2) *The middle branch*, supplies deep parts to some degree, particularly in the latero-caudal region near the connective, including a large trunk which runs down it nearly to the subesophageal ganglion. On entering the brain this large middle branch divides into a number of deep portions.

(3) *The caudal branch*, gives superficial tracheae to the whole mesal half of the brain and deeper ones which penetrate the ventral side of the ganglion near the middle line at the caudal edge. It is of two main parts, the shorter portion which divides again soon into a number of branches near the middle part of the brain and a longer more ventral portion. Each of these main branches on running to the ventral side of the brain divides into tracheoles before entering, and the larger superficial, are easily seen from the ventral side, while the larger deep branches can often only be seen as they turn in to send deep tracheoles to the central part of the brain and smaller superficial branches to the dorsal side. The large superficial ventral branches send off many fine superficial tracheoles which may be seen over all parts of the brain, in some degree parallel to larger when larger branches are near.

In the center of the brain on each side, there was found a much darker area due to the mass of tracheoles which formed a central dense tuft. (Figs. A, G, & 1 & 2.)

Following the arched nerve on each side there is a small tracheal branch from the brain which supplies the small frontal ganglion, while on each side from some other lateral source a minute lateral branch also supplies this ganglion.

THE SUBESOPHAGEAL GANGLION.

The two pairs of branches supplying the ganglion are from two sources:

First, a ventral transverse tracheal branch of large size which runs across under the ganglion and a little above it. It sends off on each side a rather large tracheole which enters the ganglion at its cephalic and ventral surface.

Second, two large branches which come from large lateral tracheae and run up to the lateral and ventral caudal edges of the ganglion.

The first, or more cephalic of these pairs of tracheae give off branches to the upper part of the ganglion. Upon entering, each divides at once into about two main parts and these short branches divide again into several and branches from these supply by both superficial and deep portions, the upper half of the ganglion, with a tracheole for each connective with the brain and small tracheoles to each of the nerves which come off in this region. The branches which go to the nerves and the connectives break up into a very fine network of tracheoles without anastomosis. In the case of the connectives, the area supplied is less than one half the length of the distance to the brain. The fine tracheoles in the connectives and the larger nerves run in a sort of circular or spiral manner. Many minute tracheoles are given off from all the branches in the ganglion.

The second or caudal pair of tracheae are larger than those just described. They come from long lateral branches from below. They supply the lower half of the ganglion, including the connectives, with tracheae and tracheoles. On entering the ganglion they each divide at once into about two main parts; the more cephalic portion of a number of branches which run towards the cephalic part of the ganglion. The other smaller portion consisting chiefly of a large branch which supplies the most caudal part of the ganglion with small tracheae and a large branch which supplies the connective of its own side by one very long twig and others shorter.

Superficial and deep branches form a dense network throughout the ganglion. There seem to be about as many small tracheoles in the middle line as at the periphery. Branches from one side cross to the opposite side in considerable numbers. Branches from the upper and lower supplying trachae interlace considerably. There are many long fine tubules with few side branches, few free ends, and no anastomoses. Although the tracheoles are abundant in all parts of the ganglion, the densest mass of them is in the central part, on each side.

The longest connective branches from the lower tracheae run only about one third of the length of the connectives between this ganglion and the first thoracic. The connectives between these two ganglia are very long and their middle portion is supplied on

each side by a tracheole not connected directly with the tracheal system of either, but from an outside source. The tracheal system of the connectives is very complete, many fine long branches wind and interlace about the connectives with few free ends and no anastomosis, although the long fine branches of different systems mingle very intimaetly. (Fig. B, H & 3.)

FIRST THORACIC.

This ganglion is supplied by a transverse branch above it much like that supplying the cephalic part of the previously described ganglion. From this transverse branch or rather arch, branches one on each side enter the ganglion laterally and a little toward the head end. There are two main branches given off at once on each side. On the left side the more cephalic is in large part a connective branch, which divides into two at the cephalic part of the ganglion; the outer of these runs up the outside of the connective for a long distance and its branches mingle with those of the median independent branch of the connective. The inner of the two just mentioned, runs to the point of origin of the cephalic connectives and sends a somewhat smaller branch along the inner side of each connective as well as a few short tracheoles which turn back into the ganglion, between the connectives. Both of these inner and outer connective branches send a number of supplying tracheoles to the upper third of the ganglion. On the left side the more caudal portion runs into and along the edge of the ganglion, towards the caudal connectives, distributing branches to the lower part of the ganglion and sending a few short branches to the connective of its own side. On the right side the larger more cephalic branch is quite different. Similar parts of the ganglion are supplied by it as by the most cephalic branch of the left side, only there seem to be more branches and there is only one small connective twig which runs on the outer side of the connective of the right side. The more caudal branch of the right side is more like its fellow of the opposite side in the number and position of the branches. In addition, a large recurrent portion was traced way up almost to the origin of the cephalic connective of the same side.

The above is a description of the main branches of the first thoracic in a single specimen. Variations of this were found in other specimens, particularly in the cephalic and caudal regions of the ganglion in relation to the connectives. The supply of the

cephalic connectives was more often nearly symmetrical and in a number of specimens there was an additional median supplying branch to the ventral region of the ganglion. This median supplying branch ran under the ventral side of the ganglion, or a little distance caudad of it on the connectives. It was found to be fully as large as one of the branches of the lateral supply. In about half of the specimens this branch was found and was apparently torn off in one or two of the other specimens. This unpaired branch divides into three a little below the ganglion, the two lateral tracheae run up to the base of the ganglion, one on the dorsal side, one on the ventral side and each breaks up into numerous tracheoles about the base of the ganglion near the middle line. The median branch runs also in a cephalic direction for a short distance and then divides into two and these again into two main parts on each side, the more cephalic portion bends out and after breaking into a number of smaller tracheae, supplies the more caudal and lateral parts of the ganglion, while the more caudal portion bends back with few twigs to supply the connective. (Fig. 4.)

The various larger branches mentioned in connection with this ganglion each give off an intimate supply of fine tracheoles, both superficial and deep and although a certain area has more tracheoles from a particular trunk, there are also numerous tracheoles winding in all directions from other systems. The area within the ganglion which receives the best supply of fine tracheoles is the central part on each side. The median line is rather clear because there are few branches in this region, although a number of the tracheoles from both sides cross this area in every direction. (Fig. 4.)

SECOND THORACIC.

In a similar way to the first ganglion a branch on each side enters from the transverse abdominal tracheal trunk. These two branches run down laterally and to the ventral and slightly cephalic region of the ganglion.

On each side the supplying trunk divides into three main portions. A cephalic, consisting of a single long branch to the outer side of the connective and a small tracheole from this which runs more medially on the cephalic connectives. A median part which breaks up into about five branches to supply the central and cephalic part of the ganglion and a caudal branch. This caudal portion is much smaller on the left side and furnishes small

tracheoles to the internal, lateral and caudal portions of the ganglion, but not much to the connective. The right corresponding branch, however, is large and besides supplying tracheae to the ganglion gives off two main parts which supply the caudal connectives.

Variations from the above description were found in other individuals studied. In some the supply to the ventral connectives were symmetrical, or chiefly from the left side. The supply of the cephalic connectives although more uniform was sometimes less symmetrical. And the cephalic connectives were often supplied at their origin by branches from a number of systems. (Fig. C, and 5.)

As in previous ganglia the nerves were each supplied by usually one small branch, each from the nearest tracheal system. The distribution of the smaller tracheoles was much like that in the first thoracic ganglion.

THIRD THORACIC.

The tracheal supply is much the same in this as in the previous ganglion.

In the specimen of the series most described as a basis for the larger branches, the left hand caudal branch instead of the right hand one furnishes most of the connective supply. (Fig. D, and 6.)

FIRST ABDOMINAL.

In the thoracic ganglia, the ventral transverse tracheal branch which sends out two tracheae to each ganglion crosses above or cephalic to the ganglia. The transverse tracheal branches supplying the next seven, cross caudal to the ganglia which they supply.

The first abdominal ganglion is much like the others in its main branches. In the series most described and figured the cephalic connective supply is symmetrical, the caudal supply mostly from the left. In other specimens mostly from the right with now and then a slightly less symmetrical distribution in the cephalic region. This ganglion and the following show a more definite lateral localization of the fine branches. (Fig. D and 7.)

SECOND ABDOMINAL.

Similar to the first. The main trunks come to it more medially. On the right side of the one of the series, the lower or caudal connective is the larger. (Fig. 8.)

THIRD ABDOMINAL.

Similar. More medial supply. Quite a symmetrical distribution of branches in all specimens studied. (Fig. 9.)

FOURTH ABDOMINAL.

Very similar to the last. In the type specimen there is an additional inner supply to the cephalic connectives from the left. (Fig. 10.)

FIFTH ABDOMINAL.

Similar to the others. In the specimen described, the left cephalic connective mostly supplied from the left side. The caudal from the right. (Fig. 11.)

SIXTH ABDOMINAL.

Nearly symmetrical in regard to the cephalic and median branches in the type, although the left is a little larger. The caudal connectives supplied largely from the left. (Fig. 12).

SEVENTH AND EIGHTH ABDOMINAL.

The seventh ganglion has quite a symmetrical distribution. The most cephalic branches on either side run up the connectives, each on its own side. Two main central parts give tracheoles to the main part of the ganglion, while a very large caudal part on each side runs down the connective with a few short branches to it and then breaks up into two main parts to supply the upper portion of the eighth ganglion, although branches run way down to the very tip of the ganglion as well. Two other main trunks come to the eighth. Two rather large tracheae run up from the caudal and lateral tracheal trunks to enter the ganglion ventrally and laterally. These two last, differ from the other supply of the other ganglia in not being connected with a ventral transverse tracheal branch. Each of these last mentioned breaks up into four or five main trunks and these supply the lower two thirds of the ganglion as well as the numerous nerves which take their origin from this region. (Fig. F and 13.)

The conditions just described for the Eighth abdominal ganglion are very uniform.

As may be seen from the description of the individual ganglia of larval Corydalis, special branches are the only ones which supply the central nervous system with air. These special branches are three on each side to the brain from a large cephalic branch; two pairs to the subesophageal ganglion, the cephalic

coming from the ventral transverse connecting branch, the caudal from the lateral tracheal tubes below the ganglion; one pair supplying the middle part of the connectives between the suboesophageal and the first thoracic; one pair supplying the first thoracic and one unpaired to the same ganglion; one pair to each of the remaining thoracic and one pair to each abdominal ganglion. The last ganglion receiving two branches from the caudal region as well as two large branches from the system of the seventh.

The tracheae of the central nervous system of Corydalis larva seem to be uniformly as outlined above, and the branches which supply the nervous system come directly from large tubes and these in most cases take their origin not far from spiracle openings in the thoracic region and from very near the gills in the abdominal region.

The larger branches in the ganglia are quite uniform in the distribution of their smaller tracheoles. There was found to be a greater variation in the connective branches in the same individual and in the ganglia of one specimen as compared with an other. The supply to the connectives however, was quite uniformly given by the tracheal systems of the ganglia at either end of the connectives. The only variations were the constant ones; first, in the additional extra supply to the long connectives between the suboesophageal and the first thoracic ganglia; second, in the supply to the connectives between the seventh and eighth abdominal ganglia, where the tracheae from the seventh ganglion furnish the connective branches.

All nerves connected with the ganglia were found to have a good tracheal supply, usually one rather small tracheole which branched many times and here as in the connectives, the branches wound about without anastomosis and without any particular indication of the direction of the nerve fibers, that is transverse as well as longitudinal branches were numerous.

The branching of the smaller tracheae from the larger was rather irregular and the course and distribution of the finest branches was very complex. Within the ganglia as a rule fewer larger branches were seen. On the surface, and each side of the middle line dense masses of tracheoles outlined the central part of the ganglion. But although there were these two dense tangles one on each side in each ganglion, numerous minute, and some larger branches crossed from one part of the ganglion to an other distant region and mingled with the branches from other systems.

The small branches within the ganglion run straight or in broad curves to a considerable extent, while the finer branches in the connectives are often wavy. (Fig. M. & N.)

A few ends were found, but no clear case of anastomosis either between systems or between branches of the same system, although it looked like it in many places because of the great length and intricate windings of the finest tracheoles. From the smallest tracheoles also there were comparatively few branches although single ones could be traced for long distances.

The connectives gave a good chance to study the distribution of the finer branches and their relation to each other. Here although two systems overlapped, no anastomosis could be found. (Fig. L.)

SUMMARY.

1. There is a very intricate and extensive supply of both tracheal branches and capillaries to the central nervous system of Corydalis larva.

2. There are three main branches to the brain on each side, entering it laterally and ventrally.

3. There are two pairs of branches to the subesophageal.

4. There are three branches, two paired and one unpaired, to the first thoracic ganglion.

5. There is but one pair of branches to all the other ganglia except the eighth.

6. The eighth ganglion has two sources of tracheae. Two branches from the seventh abdominal ganglion and two from the caudo-lateral region of the animal.

7. The supply to the connectives in all cases but one, is from the tracheal systems of the ganglia.

8. The supply to the long connectives between the subesophageal and first thoracic ganglion is in part from both of these ganglia and its middle portion is supplied by a small lateral tracheal tube.

9. Nerves supplied by only one small tracheole may have this forming a very complete network.

10. The frontal ganglion is supplied from the brain on each side along the small connective and also from two small lateral tracheae not connected with the brain.

11. There is a superficial and a deep supply to each ganglion and a very intricate network in each.

12. In each ganglion, especially the abdominal, the central area on each side is well marked by a dense tuft of minute tracheoles.

13. The large, and especially the small branches from one system cross over to the regions of other systems to a marked degree.

14. Although minute tracheoles are long and fine, no anastomosis could be demonstrated.

15. Within certain limits the tracheal supply is regular and constant.

16. The tracheae supplying the ganglia are rather directly connected with the larger tubes, not far from spiracles in the upper region and very close to gills in most of the abdominal region.

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I have especially to thank Prof. Kingsbury of the Department of Histology, of Cornell University, and the Department of Entomology of the same institution, for suggestions in the preparation of this paper.

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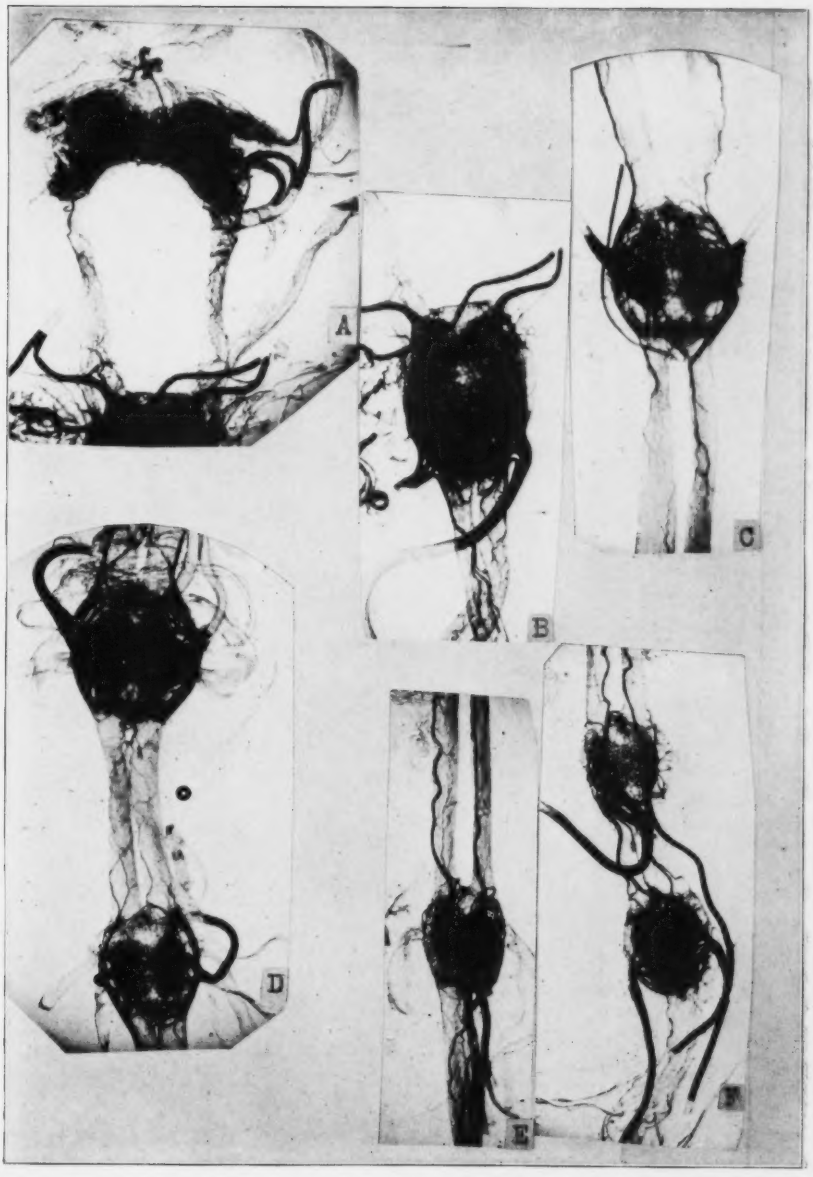

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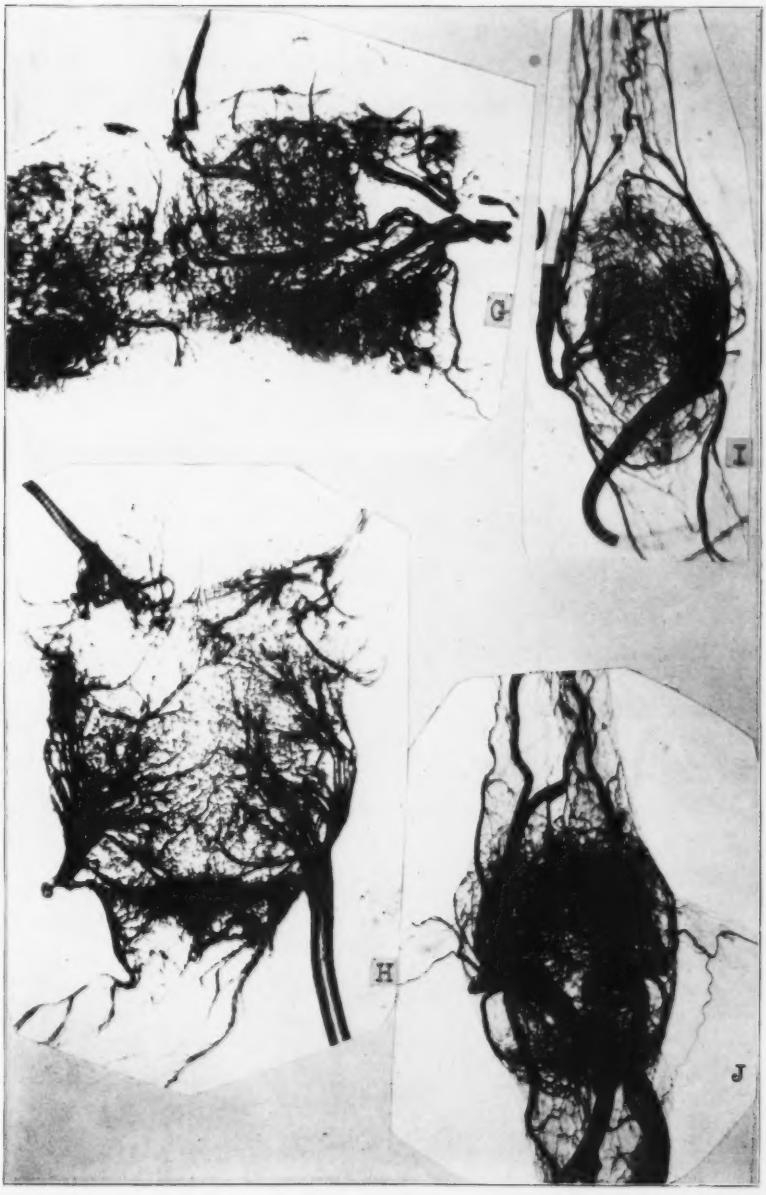

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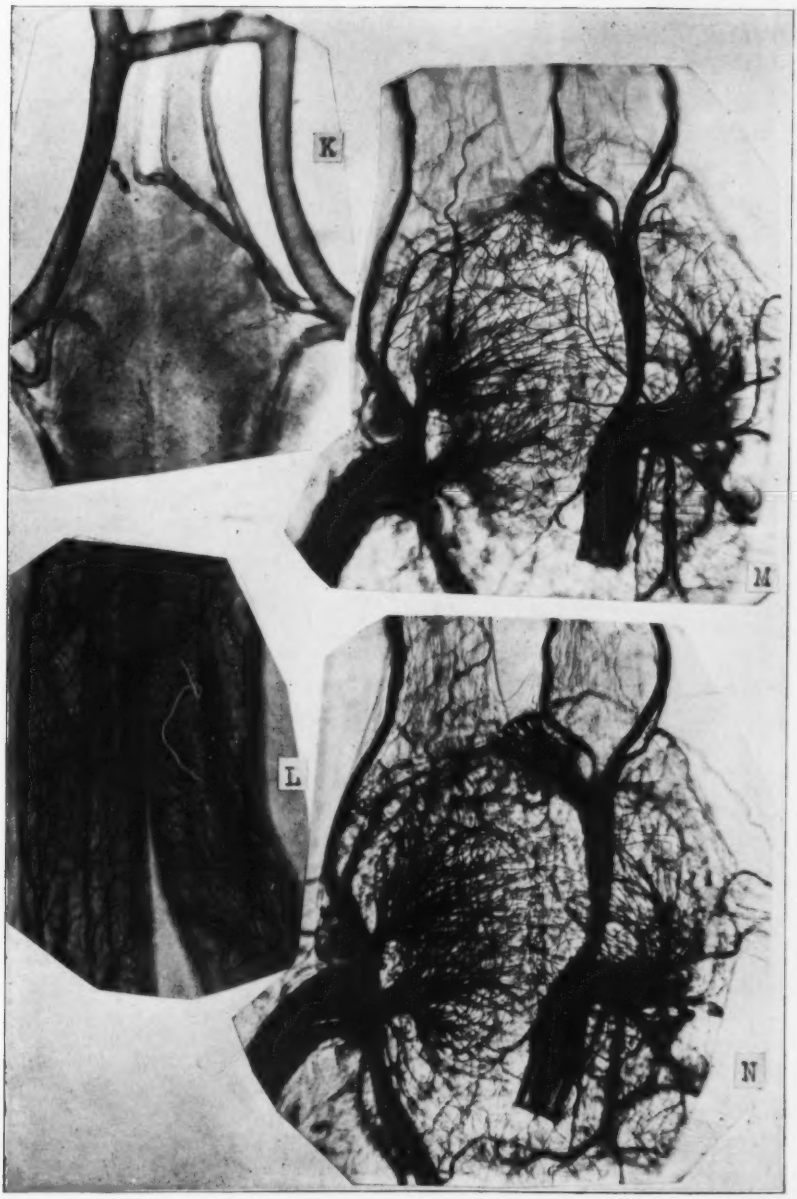

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EXPLANATION OF PLATES.

All figures indicated by letters are from photographs of the central nervous system of Corydalis cornuta larva. The dark lines and darker parts of the figures indicate tracheal tubes or dense masses of tracheoles.

Plate VIII.

Fig. A. Brain and part of the subesophageal ganglion from below. × 23.5.
Fig. B. Subesophageal ganglion from below. × 23.5.
Fig. C. Second thoracic ganglion from below. × 23.5.
Fig. D. Third thoracic (larger), and first abdominal ganglion from below. × 23.5.
Fig. E. Abdominal ganglion from below. × 23.5.
Fig. F. Seventh and eighth abdominal ganglia from below. × 23.5.

Plate IX.

Fig. G. Two thirds of the brain from below. × 50.
Fig. H. Subespohageal ganglion from below. × 50.
Fig. I and J. Abdominal ganglia from below. × 50.

Plate X.

Fig. K. Upper portion of a thoracic ganglion showing larger branches only. × 50.
Fig. L. Part of two connectives showing the mingling of two tracheal systems in each. × 80.
Fig. M. Abdominal ganglion from below at one focus. × 80.
Fig. N. Abdominal ganglion from below, same specimen as Fig. M, only at a different focus. × 80.

PLATES XI AND XII.

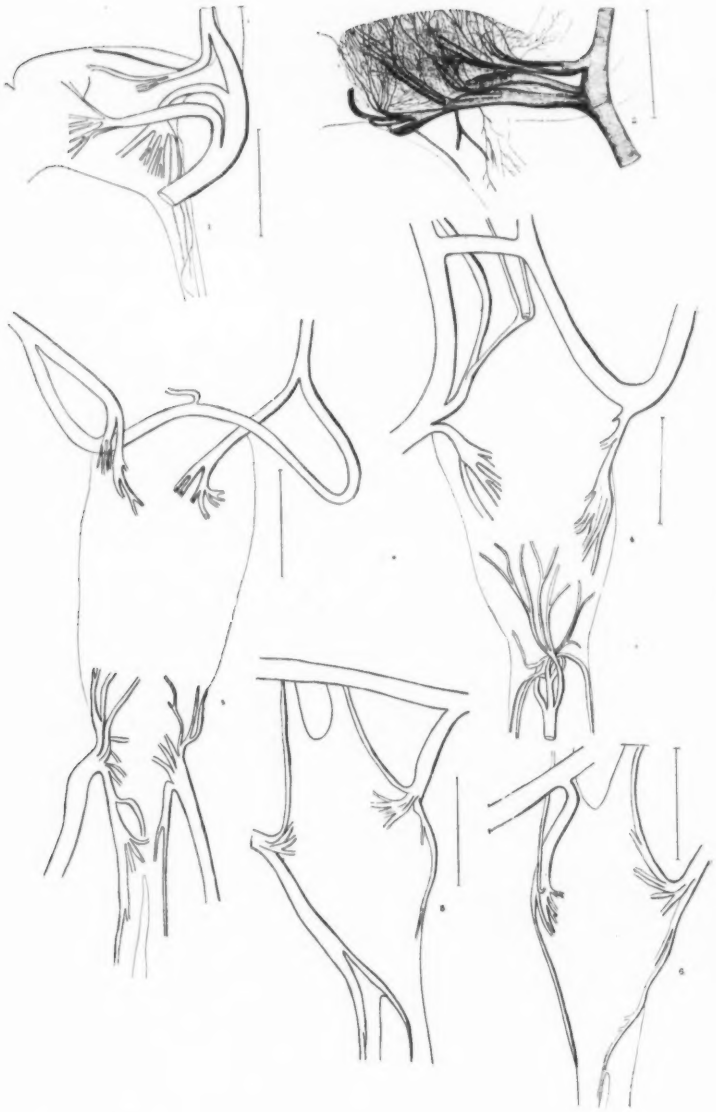
Camera lucida drawings of the main tracheal branches in each of the ganglia of larval corydalis. Chiefly from a single specimen. Each is drawn from below and the scale at the left is equal to one half mm.

Plate XI.

Fig. 1. One half of the brain showing the main branches.
Fig. 2. One half of the brain of another specimen, showing most of the branches that can be seen from one side.
Fig. 3. Subesophageal ganglion.
Fig. 4. First thoracic ganglion.
Fig. 4. Second thoracic ganglion.
Fig. 6. Third thoracic ganglion.

Plate XII.

Fig. 7. First abdominal ganglion.
Fig. 8. Second abdominal.
Fig. 9. Third abdominal.
Fig. 10. Fourth abdominal.
Fig. 11. Fifth abdominal.
Fig. 12. Sixth abdominal.
Fig. 13. Seventh and eighth abdominal ganglia.



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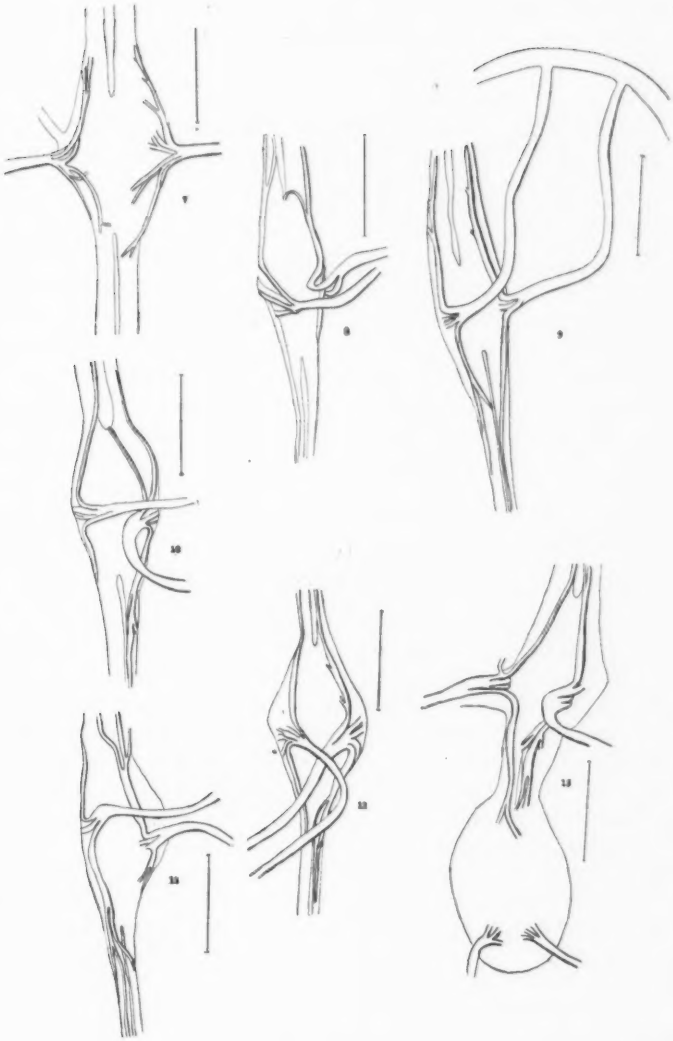

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EVOLUTION AND ADAPTATION IN THE PALPUS OF MALE SPIDERS.

JAS. A. NELSON.

The following conclusions are the results of study of 85 representatives of 21 families of American spiders, taken from the collection in Cornell University, through the courtesy of Professor Comstock.

The simplest form—structurally—of the male palpus is that found in the sub-order Tetrapneumones, which, as is well known, is recognized as including those members of the Araneida which are primative in respect to other structural characters. It will therefore be justifiable on two grounds, namely, the structure of the palpus itself, and the general structure of the members of this group—to regard this form of male palpus as the most primitive existing type, thus enabling us to form some conception of its ancient condition. It accordingly serves to indicate the point of departure from which the other more highly modified types have been developed. This simpler type of male palpus is fairly well defined, although varying in many particulars in the different members of the sub-order. Fig. 1 is a schematized representation of this type. The essential portion of the palpal organ, the bulb (*b*), is placed at the end or on the ventral surface of the sixth, tarsal, or terminal segment, if we consider the female palpus as representing the original form of the second pair of appendages. The bulb varies from long pyriform to spheroidal in shape; it is articulated at its base to the tarsal segment by a narrow zone of unchitinized integument, and bears at its summit a tapering process, or style (*s*). Within the bulb is a tubular canal, coiled in a helicoid curve. This canal is wider at its base and narrows gradually toward its peripheral end, which passes into the style and opens at its apex by a narrow aperture. Its function is to contain the sperm and it is therefore termed the semeniferous canal (represented in dotted outline). It is important to note the position of the helicoid curve just mentioned. It is placed in such a manner that its central axis, the helical line (represented in the figures by an arrow), passes through the base of the style at the distal end of the bulb, and the base of the bulb itself at its central end, in this

primitive type, and moreover it generally coincides with the long axis of the bulb, whenever this is in evidence. This line or axis is a valuable basis for orientation in the manifold changes in form undergone by the bulb in the higher families, and I will, for convenience, term it *the principal axis of the bulb*. This axis, as the figure shows, generally forms an angle of from 50 to 90 degrees with the long axis of the tarsal joint. Four characters are to be noted as marking this type of palpus: (a) the more or less cylindrical form of the tarsal joint; (b) the position of the bulb, frequently terminal and rarely, if ever, near the base of the tarsus; (c) the narrowness of the zone of articular membrane joining cymbium and bulb, scarcely wider than that between the joints of other appendages; (d) the integument of the bulb itself, which is a continuous chitinized sheet, not broken up into segments or plates. This type of bulb I propose to designate by the term *holochitinous*.

Turning to the palpal organ of a representative of the higher spider families in the Dipneumones (figs. 2–7) it is seen that the primitive type just described has undergone great alteration, especially in regard to one or more of the four characters described. These are, broadly speaking, the following: (a) change in the form of the tarsal segment or cymbium; (*c*) this has become compressed in a plane at right angles to that in which the bulb lies, so as to present an elliptical or oval outline in face view, and is moreover hollowed out beneath the base of the bulb to form the alveolus (*a*); (b) The position of the bulb is uniformly near the base of the cymbium, never, in the higher groups, near its apex; (c) the articular membrane joining bulb and cymbium has increased greatly in extent, and has become an elastic sac (figs. 6 and 7) capable of being greatly distended by blood pressure, thus erecting the bulb, thrusting it out some distance from the alveolus and away from the cymbium. It is accordingly termed the haematodocha; (d) The bulb itself has suffered alteration in that it is now generally split transversely into two or more segments, united by membranous integument. It is also frequently greatly shortened in its principal axis.

Each one of the above mentioned alterations of the primitive type seem quite evidently directed toward one end, namely, *protection of the bulb, the essential part of the copulatory organ, from mechanical injury*. Taking the above four named alterations in order: (a) Change in the shape of the tarsal joint, from

cylindrical to a flat boat-shaped form, hollowed out on the side toward the palpus, would very evidently be of service in shielding the bulb from mechanical or other injuries.

(b) Change in the position of the bulb, from an exposed position at or near the tip of the cymbium, is correlated with the change in the form of the cymbium mentioned under (a), and enables the bulb to make full use of this alteration.

(c) The distensibility of the articular membrane makes a long or projecting bulb less necessary, since it may be projected at the time of copulation, and only then.

(d) The purpose of splitting the bulb into segments or plates is, in the majority of cases, less evident, but in one large family, the Lycosidae, it enables the bulb to be closely folded together in the alveolus.

The whole evolution of the male palpus, therefore, appears to hinge on the one adaptation, and the different modifications in the form of the palpal organ are accordingly only illustrations of the different means which may be employed to serve this end. Above all stands out the constant mechanical adaptation or fitting together of bulb and cymbium to one another, often carried to an extraordinary degree. When the palpus is at rest, the bulb and cymbium together, in the majority of the Dipneumones, form a compact, more or less ovoid mass. This is brought about, gengenerally speaking, in one of five ways, thus dividing the American spider families of the sub-order Dipneumones into at least five divisions. The lines of separation between these divisions, are, of course, not always sharply marked, since transitional forms occur, but the types themselves are nevertheless quite distinguishable. They are as follows:

1. First of all are those families in which the structure of the male palpus differs little, if any, from that described for the Tetrapneumones. These families are:

Filistatidae.
Dysderidae.
Sicariidae (Scytodes).

The Pholcidae are probably also to be placed here. It is to be noted, that the cymbium of *Dysdera crocata* shows evidence of the flattening so constantly present in the higher families.

2. Fig. 2. The principal axis is greatly shortened, the bulb is in cross section nearly circular, and sinks into the circular

alveolus like a ball into a socket. The principal axis is approximately perpendicular to the long axis of the cymbium. Representatives:

Thomisidae (in part).
Agalenidae.
Pisauridae.
Oxyopidae.
Dictynidae.

3. Fig. 3. This is apparently derived from the second type. The principal axis is not only much shortened, but the bulb is elongated in a new axis at right angles to the principal axis and parallel to the long axis of the cymbium, the alveolus being correspondingly extended so as to receive the basal half of the bulb, and therefore oval or elliptical in outline. Representatives:

Thomisidae (in part).
Clubionidae.
Gnaphosidae.

4. Figs. 4, 6, and 7. The alveolus is extended so as to include practically the entire ventral face of the cymbium, reducing the latter to a mere concave shell. In the closed palpus the distal portion of the cymbium lies against the side of the bulb, in other words, the principal axis forms an angle much less than 90 degrees with the long axis of the cymbium. Representatives:

Theridiidae.
Argiopidae.
Mimetidae.
Uloboridae.

5. Fig. 5. The chitinized covering of the bulb, particularly of its distal end, is reduced in extent, so that the bulb is largely composed of thin membrane and is therefore collapsible, in its inactive condition being folded up into a flat package, almost completely contained in the shallow alveolus, which, as in the first division, is moderate in size. The principal axis is slightly oblique to the long axis of the cymbium. Represented only by the

Lycosidae.

These modifications in the form of the bulb and cymbium, which appear so clearly to be designed for the protection of the former, are aided by special modifications or structures directed

toward the same end. Two of these are worthy of mention. They are: The accessory branch of the cymbium found in the Linyphiinae and Tetragnathinae, sub-families of the family Argiopidae, (figs. 6 *a. b.*), and the expanded patella of the Theridiidae (fig. 7 *p*). Both of these structures serve to overlie and protect the base of the bulb.

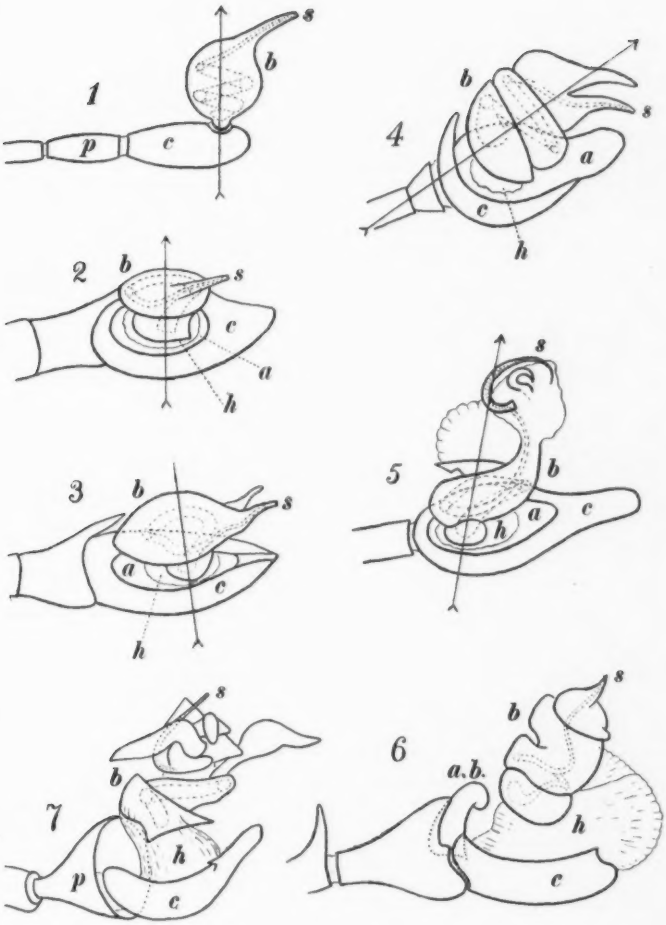
To conclude: The more complex palpi found in the Dipneumones have been developed by modification of a palpus similar to that of fig. 1. and the principal factor in their evolution has apparently been that of protection from mechanical injury.

EXPLANATION OF PLATE XIII.

Fig. 1. Diagram of ♂ palpus of the most simplified form.
Fig. 2. ♂ palpus of Misumena, slightly digrammatic.
Fig. 3. ♂ palpus of Phurolithus, from camera drawings.
Fig. 4. ♂ palpus of Araneus, schematic.
Fig. 5. ♂ palpus of Lycosa, also schematised.
Fig. 6. ♂ palpus of Erigone autumnalis, from a camera sketch.
Fig. 7. ♂ palpus of Lithyphantes corollatus, also from a camera sketch.

The strongly chitinized portions of the palpus are represented in heavy outline, the membraneous portions, including the haematodocha, in lighter outline. The semeniferous canal is represented by dotted outlines, the principal axis, in each case, by an arrow. The morphological ventral side is turned upward.

a, alveolus; *a. b.*, accessory branch; *b*, bulb; *c*, cymbium; *h*, haematodocha; *p*, patella.



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